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THE MUNICIPAL OWNERSHIP QUESTION.

In spite of the attempt to stir up public opinion in favor of the plan for a municipal electric light plant, we are very glad to note that the people of New York exhibit no enthusiasm on the subject, and that the newspapers most influential as exponents of intelligent public sentiment oppose the scheme and frown upon it. There have been "popular" meetings in support of the measure, it is true, but none that have any claim or right to be regarded as representative of anything but the socialistic spirit which pervades a certain portion of the population here as everywhere else, and that would have every man on the pay roll of the State or the municipality in a vast series of paternalised institutions. We can but express our regret to see members of the Merchants' Association consorting with that element because bills for lighting are said to be too high. If we were to propose running an opposition on municipal lines to the businesses that some of those gentlemen are engaged in, it would be a fierce howl of protest that went up from them. It is wonderful what short memories some people in New York have. Less than ten years ago this city saw in one of its sections—Gravesend, Long Island—one of the most disgraceful and disastrous attempts at a municipal plant the country has ever known. At that place Mr. Kane, a celebrated politician, invested over $120,000 of the public money in a municipal lighting plant. We doubt if it ever ran a light; but we do know that only seven or eight years ago it was a perfect wreck before it had got into operation and was sold out under the hammer for $30,000. Thus was lost over $90,000 of money raised by bonds and taxation to put into a municipal electric light plant in what is now part of Greater New York; and yet with such an example staring them in the face, the Merchants' Association wants to get some more of the same thing on an infinitely larger scale.

Beyond the injudicious or malevolent stirring up of prejudice and ill will against corporations, there is an extraordinary recklessness in this affair in the use of figures intended to prove that the city is being cheated by the present rates for arc lights. Commissioner Monroe had prepared a list of towns and cities with alleged all night, every night, 2,000-cp arc lamps, with the rates. This list the Merchants' Association has reprinted, and made its own, and issued under the title: "The Lighting Monopoly of New York City and Its Exactions." Now this list is the most deceptive, specious and plausible thing of the kind we have encountered lately, and we are sorry to note that the *New York Times* in opposing the measure, is so misled as to accept the list as valid. It is a hollow fraud. There is nothing in it to show the local conditions, or whether the circuits are overhead or underground. There is not a word as to the length of the lighting contracts, a most vital consideration. There is nothing as to the number of lights. There is nothing as to use of water power or steam. There is no data as to the cost of fuel or expense of its delivery or restrictions as to its nature. There are no data as to the cost of water. In fact an absolute absence prevails of any data that would bring the figures to an equality of conditions; and even as they stand many of them look very suspicious. Moreover, they have been boosted up with instances like Detroit, to whose inaccurate municipal plant bookkeeping we paid our respects some weeks ago, showing irrefutably the gross underestimates of actual cost, depreciation, etc. Another vaunted example is Chicago, whose claim of $53.51 "total cost" per light has been pointed to triumphantly. We have the Chicago report before us and

regard it as one of the most dishonest documents ever submitted to an unsuspecting public. Aside from a complete want of information as to the real cost of the plant—something which its founder, J. P. Barrett, said no man could ever find out—the report omits any charge or allowance for depreciation, taxes, rent, water, sinking fund, insurance, furniture and other little things! The number of lights in operation is variously stated, and every blessed one of them is rated as burning every single hour of the schedule! Not a word of outage, interruption, low candle-power, or other offset for which local companies are mulcted, is to be detected in this marvelous report.

As we have said before, we hold no brief for the lighting companies in New York, and are perfectly willing to allow that they are over capitalized. Watering stock is an economic offence for which we have no condonation to offer, in any branch of industry, and it carries its own punishment. But it has little to do with this question, for the public electric lighting is barely 5 per cent. of the New York Edison business, and hence the dividend item could swell the total cost very slightly. The main point is that on a precarious year-to-year contract, subject to just such onslaughts as this under consideration, the company has to instal, maintain and operate a most costly plant, for which it would otherwise have no direct or immediate use. New York is hiring its arc lights on the most unfavorable kind of a retail plan, and yet Mr. Monroe holds it an outrage if the city has to pay a retail price. It is obvious that long contracts and a larger service would do a great deal to bring down the price per lamp and to keep it down. That is much better to secure than to fly to the other alternative of a city plant with all its political and technical perils. Besides, we object to the assumption that an opposition company could not be found or started to give the required arc service, although the arc lighting organizations within the New York Edison system show practically nothing but deficits, we believe, since the wires were put underground.

LOW RATES AND WATER POWER PLANTS.

When a plant deriving its power from a large newly-developed water power begins to distribute electric energy to a community, there is always a temptation on the part of the management of the plant to make rates so low that after a few years come regrets that higher prices had not been initiated. We refer more especially to the class of plants where the company owning the power also does the local distributing to the various customers. Where the power company and the distribution company are separate, the problem is an entirely different one. Usually when a large water power is developed, there is immediately thrown on the market a much greater amount of electric power than the actual demand justifies. If, as is often the case, the water power takes the place of a steam plant, there is likely to be a reduction of rates all along the line, and special inducements are held out to users of large motors maintaining independent steam plants. As soon as the water power project is ready for business, the manager of the light and power company immediately begins to solicit the various steam users in his community to take electric power. Just at this point, the manager is likely to pass through one of the most trying periods in the history of his project. The various small factories have their steam plants already installed, and their owners very likely think that they produce power much more cheaply than they actually do. They are at first very much disinclined to abandon their steam equipment and put in an electric motor involving an additional investment of capital. The great majority of these power users are very slow about taking the new power. The manager of the water power plant sees a large investment lying idle and quantities of water going to waste. In nine cases out of ten, he will become desperate to increase his load faster and begin to lower rates in order to get his plant loaded. When once the ball has started rolling, he begins to take on customers rapidly and wakes up some fine day to find his plant fully loaded and too much of his load taken on at a price which represents little or no profit.

The moral is to scrutinize long-time contracts taken at rates which may turn out to be too low to permit of a profit. "But," says the manager whose plant is still without a load, "I cannot afford to have my plant lying idle day after day, waiting for these people to apply for electric power." This is quite true, but it must be remembered that in spite of all that has been said to the contrary, business methods and engineering methods are largely influenced by the force of custom, and at times can almost be called fads. When once a number of power users in a community get started to take electric power, the rest fall in line without solicitation. It is largely a matter of getting the first few started. The policy of the management should, therefore, be that of avoiding "entangling alliances" in the way of losing contracts or of very low rates granted to certain consumers at the outset, which practically govern the price of power to all consumers taken on thereafter. The question is, How can this be done?

Granting at the outset that it is necessary to offer some special inducements to power customers in order to get a load and in order to create a fashion, as it were, for the use of electric power, the advisable thing to do is, of course, to make any concessions that are made in such form that they will be only temporary and will have no influence on the receipts after the first year or two. One way of doing this which suggests itself is to follow out a practice similar to one used by the owners of large office and flat buildings in getting new tenants; that is, to offer power almost free for a short period of time at the beginning of the contract. This would help induce a man to make the investment necessary in electric motors at once, while otherwise he might continue with his engine until the steam plant wore out. On the whole, however, it is a question whether it is necessary to make special concessions even at the outset. A water power plant is a valuable asset, even if the immediate load upon it is not great. As one distinguished engineer put it, "If I had a water power plant and some one would pay the interest on the investment, until such time as it could be utilized, no one could buy it from me." Of course, the rub comes in paying the interest on the investment. Unfortunately, no company has discovered a philanthropist willing to bear this burden until the plant is loaded up to a paying basis, but it certainly is better to run with a light load for two or three years than to load up immediately with power supplied to customers only at a loss. This warning is not needed by those who have been through the experience once.

CODE OF THE GERMAN ELECTROTECHNICAL ASSOCIATION.

A recent number of the *Elektrotechnische Zeitschrift* (February 19) prints the last report of the code committee of the German Electrotechnical Association. It comprises 44 columns of matter, and is very interesting reading. The report goes into many directions that our National Electric Code does not touch, and on the other hand, some of the rules in our national code do not appear to have their counterparts in the German report; but the "must nots" and "forbiddens" are common to both. The report of the "Verband Deutscher Elektrotechniker" sets forth at some length the symbols and letters of reference that plans and engineering drawings should bear, as denoting specific and prescribed features of construction. Thus, a permanently connected incandescent lamp is denoted by a little maltese cross,

or multiplication sign, and a lamp with a switch or socket-key, is similarly denoted by such a maltese cross with a wavy line appended to its waist. Arc lamps are shown by a pair of small concentric circles, dynamos by a circle and brushes. Alternators and direct-current machines do not appear to be directly distinguishable in this system; but no doubt the system, as a whole, would enable the reader readily to discriminate in any given case.

It is interesting to see the rule that the neutral conductor of direct-current three-wire systems must be grounded. On the other hand, there are various directions that appear to be at variance with the rules of our National Electric Code. It seems desirable that upon many of these questions, as well as upon many questions of standardization, international agreement and consensus of opinion should be reached. Minor differences of standardization, modes of construction and rules for installation, must inevitably occur in different countries; but it is advantageous for all countries to possess in common an international system of electric rules and standards, so far as it is expedient to unite. This question is one which might properly be considered by an international electrical congress.

High-Tension Insulation.

The Institute symposium on this important topic for once brought out a deal of valuable discussion. The first paper, that of Mr. Mershon, provoked a debate on the material and insulating value of pins that really added much to our knowledge of the subject. Mr. Mershon started with the principle that the longitudinal section of a pin of uniform strength with varying length is expressed by a simple cubic equation, and the graphical construction shows a gracefully tapering pin in outline suggestive of the Washington monument. Following upon the statical theory is the proposed practical modification for commercial requirements. All pins terminate in an extremity or shank of the same dimensions and form, for all sizes. This is the portion of the pin that is inserted into the insulator. The stem of the pin, or that part which resides between the cross arm and the insulator gap, is tapered in approximate accordance with theory, and varies in length and thickness according to the size of the pin and of the insulator it has to support. The root of the pin, or that part which is inserted in the cross arm, is also variable, in lesser degree, with the general size of pin. These proposed standard pins are of a form readily manufactured and easy to keep in stock.

In the discussion the proposed standard was overhauled pretty thoroughly, and the consensus of opinion was upon the whole favorable. But one thing is evident at the outset, that the number of standard sizes should be kept as small as possible. At the present time pins for high-tension lines are practically all special, for the commercial regular pins are too small for anything but rather light transmission work. Granted that a larger pin is a necessity, it would be an excellent thing if even a single size were sufficiently standardized to be generally available without a long struggle with the maker over the specifications. The weak point of the Mershon pin is in the thread, as was pointed out in the discussion, and in our opinion it would be materially improved by making the threaded portion one and a quarter inches in diameter and three inches long. A "ten-inch" pin thus modified would serve admirably for the great majority of heavy transmission work. It would be amply strong and in particular would stand up better in the thread. The modern heavy high-tension insulators need extra support, particularly in running lines over rough and windy country, and this is best given by a rather thick and stubby pin. If a size like that mentioned could be standardized as a start in the good work, it would prove very convenient.

As to the mooted question of wooden versus iron pins, much interesting information was brought out. It has been shown that wooden pins, particularly at high voltage, and in moist climates, suffer from what has aptly been termed "Digestion." By the very interesting Niagara experiments this has been determined as due to nitric acid formed by the brush discharge from the high-tension lines acting on the moisture of the atmosphere. It is, in short, Mr. Bradley's beautiful process applied on a comprehensive scale just where it is least wanted. It would be very interesting to know at what voltage on the line such action begins to take material effect. We are inclined to think that below 20,000 volts or thereabouts this action is very small, so that in the majority of plants it will not be felt. But at voltages which show powerful brush discharges from the wires it must be looked out for. Treating the pins undoubtedly helps matters somewhat, but treating as ordinarily practised does not strike us as sufficiently thorough.

Knowing the active cause of the digestion, experiments on treatment intended specifically to resist nitrous fumes would be decidedly profitable. It is fairly safe to say that any treatment satisfactory in this respect would be efficient in improving the insulating properties of the pins. But we think the treatment should be applied in a vacuum pan, rather than by mere boiling. Boiling in oil does not saturate the pins properly, as is at once shown by beginning to pump off the air and vapor. And the vacuum treatment is not troublesome, for a big aspirating water pump is amply sufficient to give the necessary vacuum. Supposing the treatment to be efficient it seems to us that a wooden pin may be made to answer admirably even at very high voltages. As between wood and iron, we grant that the former does not add much to the insulation, for that must depend on the insulator itself. But we do not see that anything would be gained by transferring the seat of digestion from the pin to the cross arm, and in the case of a high-potential line that action would certainly take place if an iron pin were used, since the same causes would be steadily at work in the one case as in the other. Moreover, the mechanical strains on the insulator from the use of iron pins are much more severe than in the case of wood, and at best the iron pins are costly. They are indubitably stronger than wooden pins, but the latter are abundantly strong for their purpose if properly designed. We feel, therefore, that the case against wooden pins is hardly made out as yet, and will not be until considerable experience with iron pins has accumulated, particularly in rather damp climates.

The discussion of Mr. Blackwell's paper on insulator testing brought out in this connection the fact that if insulators were to be used with iron pins, they should be tested with the pins in place and not merely by filling the thread cavity with salt water; for insulators that would stand the latter test may quickly break down under the mechanical strains and local action of the former. With respect to the relative merits of glass and porcelain insulators, the usual differences of opinion were in evidence and the general conclusion seemed to confirm what is already pretty well established, that first-class porcelain is mechanically and probably electrically a trifle better than glass, but requires more elaborate testing; while a good article of glass is entirely satisfactory for the vast majority of cases. Altogether, the discussion brought into prominence the fact that the voltages now to be considered seriously are those of 40,000 volts and above, that under this figure it is pretty smooth sailing for the engineer, and that above it lies a debatable ground in which experiments on a large scale are greatly needed.

Some Difficulties in Long Distance Electric Transmission.

In a paper recently read before the Cleveland Electric Club, Mr. Paul M. Lincoln considered in detail some of the difficulties that have been encountered in the development of long-distance electrical power transmission. Referring to high tension in power houses and other interiors, he said it has been customary in the past to place considerable, if not implicit, reliance upon the rubber of a rubber-insulated cable. The experience of Mr. Lincoln has been, however, that for such insulation, rubber is not reliable. His first experience came at Niagara Falls some years ago. At the time of raising the voltage on the Niagara-Buffalo line from 10,000 to 20,000 volts, a change in arrangements made necessary the rewiring of the transformer station in so far as the high-tension end was concerned. For this purpose there was used a wire covered with a first grade of rubber insulation. A number of tests were made on short sections, and the insulation on none of these tests broke down short of 70,000 volts. An entire reliance was placed on the insulation of the rubber and no particular pains were taken, therefore, with the mountings. These mountings were small clamp porcelains.

Before the job was put into service it was given a test as a whole of 50,000 volts for ten minutes which it stood perfectly. After one week of operating on 20,000 volts, three-phase, two breaks occurred in the rubber insulation. The normal voltage strain on this insulation was only about 13,000 volts, so that there was a factor of safety of at least five. Both the break-downs occurred at the mountings, where in order to get to the ground it was necessary both to puncture the rubber and pass over about one inch of porcelain surface.

It has always been noticed that whenever any conductor is brought near the surface of high-voltage cable, brush discharge of more or less intensity takes place at the surface of the cable. The breaks in the insulation are almost certainly caused by some chemical action on the rubber, caused by this brush discharge. Whether it be ozone or nitric acid or something else that is generated by this brush discharge is not material. The observed fact remains that this brush discharge causes a deterioration of the rubber of the cable more or less rapid, which destroys in time its insulating qualities. In this opinion Mr. Lincoln said he was confirmed not only by many instances in his own experience, but by that of many others as well.

Another instance in which practically the same action occurred was that of a suburban railway, which generated power at a central station and transmitted it at 20,000 volts, three-phase, to a number of sub-stations. The high-tension wiring, both in the central and in the sub-stations, was composed of a good grade of rubber-covered wire, incased in lead. In order to prevent accidents to employees, it was thought best to ground the lead covering of the cables. In this case a brush discharge took place on the insulation of the cable at the point where the lead ended. In less than six months over 100 breaks occurred at various points, but all within three inches of the point where the lead casing of the cable ended. The cure in this case was to remove the lead entirely. Since that has been done very little trouble has been experienced.

A break-down of insulation causing either a ground or short-circuit is injurious, not only in causing an interruption to service at the time, but also in giving rise to electrical surges in the circuit which throw additional strains on the insulation on other parts of the circuit.

Thus, a break-down in one part of the system may cause an over-straining of insulation in a distant part of the same system. With electric waves, the highest potentials will occur at the reflecting points and in an electrical system it is difficult to tell where these reflecting points are going to be. Further, these insulation strains are not confined to the high-tension side of the system. A transformer may act to a certain extent as a condenser, and the sudden discharge of one side of this condenser may transmit to a certain extent electric surges to the other side. In the case mentioned above, for instance, where more than 100 break-downs occurred on rubber-covered cables, at the same these break-downs were occurring on the high-tension side of the circuit, considerable trouble was experienced with the apparatus on the low-tension side. Instruments on the low-tension side seemed to suffer particularly. A number of breaks occurred also in the insulation of some rotary converters. Since the cause of the high-tension break-downs—the lead of the rubber-covered cable—has been removed, practically no trouble has been reported from the low-tension side.

An approved method of doing inside wiring is to mount the wiring on insulators of the same character as would be used if wiring was to be exposed to the weather. The rubber insulator should be retained, but its only function is to protect employees or others in case of a casual contact with the wiring.

It seems probable, however, that the loss of power in brush discharges from the surface of the conductors as well as the disintegrating effect that this brush discharge is likely to have on the metal of the conductor, will place a limit to the increase of voltage. As voltages increase it becomes more and more difficult to insulate. Insulation of the line, however, is not the only thing. The insulation of the transformer and other apparatus attached to the line must also be considered.

Lightning is another source of trouble to the transmission superintendent. There is present the constant menace that the unusual electrical strains caused by lightning discharges will cause breaks in some part of the system's insulation. Lightning arresters properly designed and properly installed will take care of a great deal of such trouble, but to take away all dangers of break-downs from this source is practically impossible. There is one effect from lightning often overlooked. Lightning storms are usually accompanied by rain which causes the insulators all along the line to become thoroughly wet. A sudden electric strain such as is caused by lightning discharged in the neighborhood, is very apt to go to ground across the film of water on the insulator and down the pole, instead of over the lightning arresters at the ends of the line. In other words, the excess of potential necessary to break down to earth by way of a wet insulator and pole is not far different from that necessary to break over the lightning arrester.

New York Meeting of the American Electrochemical Society.

The following arrangements have been made for visits during the meeting next week in New York of the American Electrochemical Society: For Friday afternoon there are three parties scheduled. Party A will leave the Chemists' Club, 108 West Fifty-fifth Street, at 2 P. M., and arrive at the office of Willyoung & Gibson Company, 40 West Thirteenth Street, about 2.30; leave at 3 P. M., for Crocker-Wheeler Electric Works at Ampere, N. J., taking Christopher Street Ferry at 3.30, arriving at 4.20, and returning at 5.25 train to New York. Party B will leave at 2 P. M., arrive at Sawyer-Man Electric Company's works, 510 West Twenty-third Street, at 2.30; leave at 3.30, arriving at Eimer & Amends (special exhibit), Third Avenue and Eighteenth Street, at 3.45; leave at 4.15, arriving at Cooper Union, Third Avenue and Eighth Street at 4.30. Party C will leave at 2 P. M., arrive at U. S. Electro-Galvanizing Company, 9 Park Avenue, Brooklyn, at 3 P. M.; leave 3.30, and arrive Brooklyn Navy Yard at 4 P. M. Two parties are scheduled for Saturday afternoon, April 18. Party A will leave at 2 P. M., arrive at New York Edison Station, Thirty-eighth Street and East River, at 2.30; leave at 3 P. M., arrive at Manhattan Railway Company power house, Seventy-fourth Street, at 3.30; leave at 4 P. M., arrive at power house of Metropolitan Street Railway Company, Ninety-sixth Street and First Avenue, at 4.15; leave at 4.15 for Columbia College, West 116th Street. Party B will leave at 2 P. M. to inspect the Rapid Transit tunnel at Fifty-ninth Street and Broadway, leaving at 3 P. M. for Columbia College.

On Thursday evening there will be a banquet at the German Liederkranz clubhouse, 111 East Fifty-eighth Street, at which the following gentlemen will be guests: Dr. Walther Nernst, Göttingen, Germany; Mr. T. J. Baker, president of the American Chemical Society; Mr. Charles F. Scott, president of the American Institute of Electrical Engineers; Dr. William McMurtrie, president of the Chemists' Club, New York City; Mr. James M. Dodge, president of the American Society of Mechanical Engineers; Mr. V. Coblentz, president of the New York section of the Society of Chemical Industry; Dr. A. R. Ledoux, president of the American Institute of Mining Engineers; Mr. F. A. Ringler, president of the German Liederkranz; Dr. H. W. Riley, chief chemist of the Agricultural Department, Washington, D. C., and Prof. Samuel Sheldon, president of the New York Electrical Society. A musical programme for the occasion has been arranged by Mr. Carl Schlegel, of the German Liederkranz, assisted by Mrs. Annie Eisen. Ladies will be at the banquet.

Six Niagara Power Installations Under Way—A Million Horse Power to be Developed at Niagara Falls.

By Frank C. Perkins.

SIX great power companies are now installing or preparing to install power plants on the American and Canadian sides of Niagara River, having a total ultimate capacity of over one million horse-power. While a large part of this power will be utilized by manufacturing plants and electrochemical industries in the neighborhood of the Falls as well as transmitted to Buffalo, Toronto and other cities within a radius of 100 miles, it is hard to conceive of a market sufficiently great for so vast amount of power without taking advantage of long-distance electric power transmission. There seems to be little doubt but that Buffalo and the other cities will ultimately obtain power at very low rates, as competition will doubless be severe when all of the large power plants are in operation.

A new electric lighting company has just been incorporated at Albany to operate in Buffalo, and in the towns of Tonawanda, Cheektowaga and West Seneca, Erie County. It is known as the Frontier Electric Lighting Company and has a capital stock of $800,000. It is said to be closely connected with the interests of the Buffalo Gas Company, and among the directors are mentioned Alex. C. Humphreys, Franklin D. Locke, Frederick Strauss, Robert L. Fryer, Stephen Peabody and William Riselay, of Buffalo and New York. That the plans of the new company include the use of a large portion of the new power about to be generated at Niagara Falls can hardly be doubted.

A new power company known as the Toronto Power Company has made application to the Victoria Park Commission for a franchise, and it was approved by that body after which it was referred to the Ontario Cabinet. There is little doubt that the franchise will be granted, which will make three power companies on the Canadian side and three upon the American side of the river. The Toronto company asks for a franchise to build a power house between the sites of the Ontario Power Company and the Canadian Niagara Power Company. From thirty to fifty million dollars capital will be required to carry on these gigantic power developments at Niagara Falls, more than half of which has already been expended or is being expended in present installations.

The power installations below the falls will include those of the Ontario Power Company on the Canadian side, near the Horseshoe Falls, and the Niagara Falls Hydraulic Power & Manufacturing Company below the bridge not far from the Whirlpool Rapids. The president of the Ontario Power Company is John J. Albright, of Buffalo, and this company has a franchise and agreement with the Canadian Commissioners of Victoria Park for the development of power. The 800-ft. dam of this company extends out into the river through seven or eight feet of swift-running water. The power station will be located in the gorge below the falls at the water's edge, and will be continually in the spray from the falls. The penstocks will run through tunnels in the cliff and be fed from supply pipes about 18 ft. in diameter through the park, finally passing down to the turbines in the power house, the site of which is now being excavated below the falls.

Fig. 1.—Interior of Power House No. 2, Niagara Falls Power Co.

In addition to the Toronto Power Company now asking a franchise, the Ontario Power Company is preparing for an ultimate output of 400,000 hp, of which 50,000 hp is under construction. The Canadian Niagara Power Company has its first wheel pit, power house and tunnel well under way, which when completed will have a capacity of 110,000 hp, with a possible enlargement to double this output.

The Ontario Power Company, instead of having a surface canal, will convey its water through large pipes nearly 20 ft. in diameter, covered as they pass through the park and over the bank to a power house in the gorge below the Horseshoe Falls. This company has run a cofferdam out into the Niagara River and down this stream above the Dufferin Islands about 800 ft., thus directing the water during construction, after which it will be restored again to this section.

On the American side the Lower Niagara River Power Company has recently secured from the State of New York a franchise to develop 200,000 hp, and the new power house of the Niagara Falls

Power Company in connection with power house No. 1 will make a total of 105,000 hp, which will be available with the present tunnel, which is 7,000 ft. long, and passes under the City of Niagara Falls.

The present large power canal and the two 11-ft. and 8-ft. penstocks of the Niagara Falls Hydraulic Power & Manufacturing Company are now supplying water for turbines of from 30,000 to 40,000 hp, and with the enlargements contemplated and now under way, the output will exceed 100,000 hp.

The six great power companies, three of which will operate plants on one side and three on the other side of the river, will thus control

FIG. 2.—POWER HOUSE NO. 2, NIAGARA FALLS POWER CO.

a million hp of energy in the near future without seriously drawing upon the power which Niagara is estimated to be capable of developing.

The Niagara Falls Hydraulic Power & Manufacturing Company, whose secretary and treasurer is Mr. A. Schoelkopf, has a grant for 125,000 hp, and the canal through the City of Niagara Falls is being widened and deepened for increasing the capacity of the plant, work being carried on both night and day. Power house No. 1 at the edge of the river below the bank on the American side now has in operation five double discharge turbines of 2,900 hp each, operating at a speed of 250 r.p.m., one of 2,800 hp and four of 2,300 hp each. The three 1,650-hp, double-discharge turbines operate at the same speed as those mentioned above, while a 1,900-hp, double-discharge turbine is in operation at a speed of 300 r.p.m. Two Lombard and two Ellicott governors are used for controlling the speed on four of the turbines.

The electrical generators are all directly connected to the horizontal turbine shafts. Eighteen of these generators are owned by the Pittsburg Reduction Company, and the direct current which is generated at 300 volts is used for reducing aluminum from the ore. Six of these machines are of 560-kw capacity, four are of 1,000-kw and eight of these dynamos have an output of 750 kw.

The three 1,000-kw, direct-current machines supplying current to the Acker Process Company at 325 volts, as well as the two 875-kw, 175-volt machines used by the National Electrolytic Company, are owned by the power company. This is also true of the 200-kw continuous-current dynamo supplying current at 135 volts for the Vermilion Chemical Company.

In addition to the above electrical equipment for electrochemical work, two 560-kw, direct-current, 550-volt generators are used for supplying current for electric railway and power purposes, and one 750-kw alternator generates current at 2,200 volts and 125 cycles and is owned by the Buffalo & Niagara Falls Electric Light & Power Company.

A new power station has been started on the American side of the river near the water's edge in the gorge below the falls by the Niagara Falls Hydraulic Power & Manufacturing Company. This power station will be capable of developing 80,000 hp, or more than double that of the present power plant owned by this company. It is being installed several hundred feet below the present power house, the pit, penstock and interior of which are seen in the accompanying illustrations. The water will be taken from the canal which passes through the city of Niagara Falls. This canal basin will be increased in width to 50 ft. and in length by about 500 ft. toward the north, and it will also be deepened to supply the required amount of water.

As in the present power house No. 1, the penstocks will pass over the cliff and down the face of the high bank to the turbines below, but it is stated that several penstocks will be employed, each serving a single turbine, instead of one penstock serving several comparatively smaller turbines as in the present plant. The turbines are to be of the horizontal type and the units will be of 8,000 hp each, ten being necessary to complete the installation as planned. Mr. Wallace C. Johnson, who is the consulting hydraulic engineer in charge of the work of the Niagara Falls Hydraulic Power & Manufacturing Company, has had a vast amount of experience in this work, having acted in the same capacity in connection with the former installation of this company, as well as the great plant of the Shawinigan Falls Power Company, in Canada.

The penstocks of the Niagara Falls Hydraulic Power & Manufacturing Company, which connect the power canal with the turbines in generating station No. 1 below, are 8 ft. and 11 in. in diameter and were constructed by Struthers, Wells & Co. These two penstocks supply the water for five new turbines built by I. P. Morris & Co., as well as five Jonval-Geyelin turbines and four Leffel turbines. These wheels have capacities up to 3,000 hp each, the total output of the power house being from 35,000 to 40,000 hp.

The effective head of the hydraulic power plant is 216 ft. and the surface canal has only a loss of 2 ft. head, while it is stated that the loss of head in the tunnel of the Niagara Falls Power Company is about 50 ft. The surface power canal supplying this power house below the cliff passes through the City of Niagara Falls and is 4,400 ft. long; its present width is between 250 and 300 ft. near the entrance, narrowing to 100 ft. for half a mile and then again narrowing to about 75 ft. It discharges into a basin about 300 ft. from the edge of the cliff, which is about 400 ft. long and about 75 ft. wide, running parallel with the gorge; as the canal is enlarged this basin may be increased to 100 ft. in width, its depth being from 8 to 14 ft. The

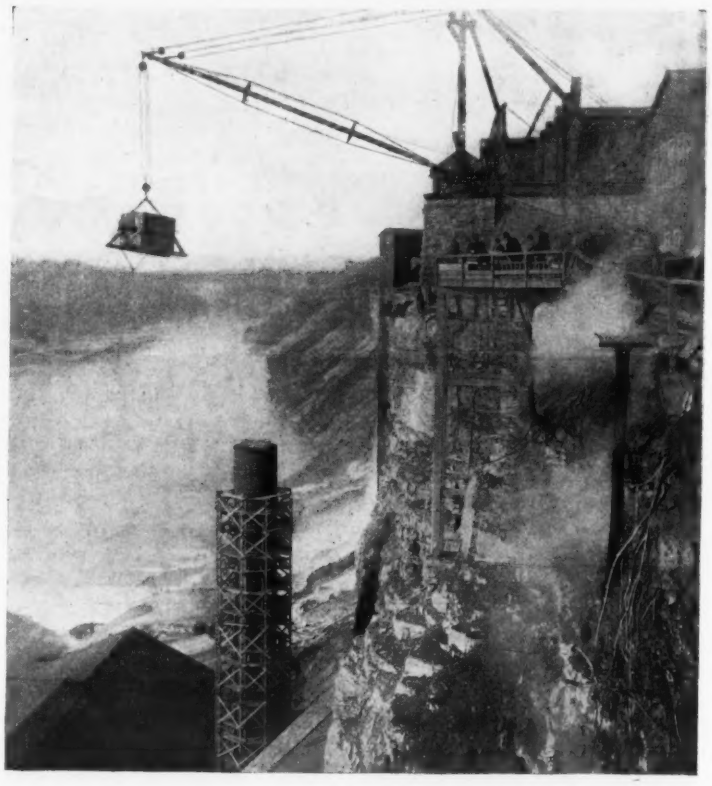


FIG. 3.—PENSTOCK UNDER CONSTRUCTION, NIAGARA FALLS HYDRAULIC POWER & MFG. CO.

water from this basin is used for operating the various turbines along the bank in the various mills as well as for supplying the water to the two 11-ft. and one 8-ft. penstocks of the electric generating power station below the bank.

The power house of the Niagara Falls Hydraulic Power & Manufacturing Company is constructed of stone and steel. The original 8-ft. penstock was constructed several years ago and supplies water to four Leffel wheels, each having a capacity of 2,250 hp. To three of these turbines are direct-connected, direct-current generators supplying current for the reduction of aluminum at the plant of the Pittsburg Reduction Company on the upper bank. The fourth

turbine of this set drives two generators, one of which supplies current for the Lewiston & Youngstown Railway and various power users, and the other operates the Niagara Falls & Lewiston or Great Gorge Railway.

The original power house was increased in size to 120 ft. in length and 100 ft. in width, and five additional turbines of the Jonval-Geyelin type were installed, each of from 2,500 to 3,000 hp. These turbines are fed by the first 11-ft. penstock, which has a capacity of 12,500 hp. It is connected with the forebay by an elliptical bell mouth and is carried out from the cliff horizontally for a distance of about 50 ft. and then drops vertically to the power house a distance of 200 ft.

The penstock varies in thickness from 5/16 in. to 1⅛ in. and an air chamber is provided to act as a cushion preventing severe shocks from the vertical movement of such a great quantity of water. It passes horizontally beneath the power house floor and is connected with a series of five 60-in. hydraulic valves connecting the turbines with the penstocks. The discharge pipes from the turbines project laterally and then downward, connecting with the draft tubes. By means of these draft tubes, which are nearly 23 ft. in diameter, the effective head of the turbines is largely increased and this method has also been adapted in the new power house of the Niagara Falls Power Company, resulting in an output of 55,000 hp in the new power house from the same amount of water which gives 50,000 hp in the old plant using the other style of turbines without the draft tube.

side of the canal are somewhat different from those mentioned above, as they are of the internal discharge type utilizing draught tubes and thus increasing the head by about ten per cent. There are, therefore, to be 11 turbines installed in power house No. 2, each of a capacity of 5,000 hp, and to be built by the same manufacturers, I. P. Morris & Co., of Philadelphia. These turbines were designed by Escher, Wyss & Co., of Zurich, Switzerland, who also designed the 10,000-hp turbines for the Canadian Niagara Power Company. The first six governors were built by A. Falkenau, of Philadelphia, and are of the hydraulic oil pressure type built by the Swiss engineers last mentioned.

Each of the 11 units develops 5,000 hp with a turbine speed of 250 r.p.m. The regulation, it is said, will be very close with the new oil-pressure governors, not exceeding 5 per cent., with a load variation of 100 per cent. and much smaller variations for smaller changes in load.

The water from the turbines of both power houses is carried away by a tunnel over 7,000 ft. long passing under the City of Niagara Falls and emptying into the river below the falls at the base of the cliffs near the abutments of the upper arch bridge. The wheel pit of power house No. 2 was constructed by the National Contracting Company. The pit is 18½ ft. wide and about 180 ft. deep and 464 ft. long. The forebay is 40 ft. wide and extends along the length of the building. The new Francis inward discharge turbines for the operation of exciters will operate under a head of 145 ft., and four of

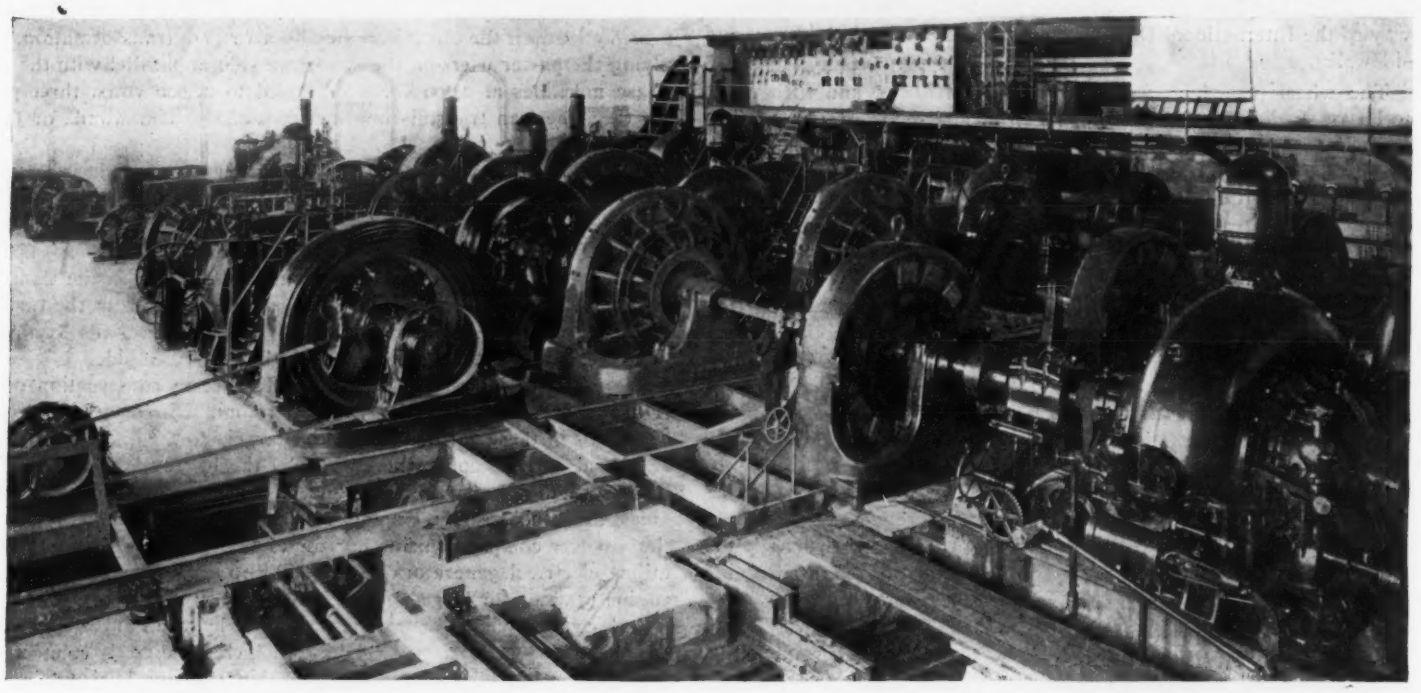


Fig. 4.—Generating Room, Niagara Falls Hydraulic Power & Mfg. Co., Power House No. 1.

The Jonval-Geyelin turbines in the power house below the cliff each weigh nearly five tons; the wheels are made of bronze and are located in the draught tube casing one on each side. There are 34 buckets on the runners with a total area of 140 sq. in., while the guide wheel has 20 runners of about 150 sq. in. total area.

The water for the Niagara Falls Power Company's plant above the falls is taken from the upper river and led to both power houses No. 1 and No. 2, by a canal 250 ft. wide, 12 ft. deep and about 1,700 ft. long, seen in an accompanying view of the new power house. It is of a capacity sufficient for the 105,000 hp to be developed in the two power stations. Power house No. 1 covers a wheel pit 20 ft. wide and 178 ft. deep with a length of more than 400 ft. There are ten penstocks in this wheel pit each about 8 ft. in diameter, supplying water to 10 double Fourneyron turbines built by I. P. Morris & Co. and designed by Faesch & Picard, of Geneva, Switzerland. Each of these turbines delivers 5,000 hp under a head of 136 ft. and a speed of 250 r.p.m. These wheels discharge at full load 430 cubic ft. of water per second, entering between the wheels, about half rising and rushing out through the upper wheel, and the rest passing downwards operates the lower wheel. The water rising to the upper turbine supports a portion of the weight of the shaft and moving parts connected with it, varying according to the position of the gates.

The new turbines installed in power house No. 2 on the opposite these are already in place. The first six turbines in the new power house are directly connected to vertical two-phase external revolving field generators of the same general type as those in power house No. 1 with certain modifications as to ventilation, means for carrying the exciting current to the field coils, and other changes. The remaining five turbines will drive vertical generators having internal revolving fields. At the bottom of the wheel pit a chamber is excavated which is supplied with vertical turbines driving direct-current generators as exciters; these machines also supply current for lighting and operating direct-current motors about the power house. Each of the four exciter turbines operates at a speed of 750 r.p.m., and is controlled by a separate governor. The discharge water from wheel pit No. 2 is carried by a 600-ft. extension of the main tunnel. This tunnel, which has a capacity of 100,000 hp, was recently tested by allowing the full power from station No. 1 to pass through with 10 turbines running and additional water from wheel pit No. 2 sufficient to develop the full power capacity of the tunnel. The test was satisfactory in every way. The discharge water from the two wheel pits attained such a velocity in its flow to the tunnel's mouth below the falls, that it shot across the entire river to the Canadian side of the stream. The tunnel was carefully inspected and found to be in good condition after several years' operation of the power plant No. 1. The hydraulic installation on the Canadian side, being developed

by the Canadian Niagara Power Company will utilize the same general scheme as has been so successfully carried out by the Niagara Falls Power Company on the American side. That is, the water will be first led into a canal, carried by penstocks vertically to a depth of nearly 200 ft. and the discharge water carried away from the turbines which will have draught tubes, by a tunnel connecting the wheel pit with the river below the falls.

The new power development of the Canadian Niagara Power Company is well under way and an initial development of five 10,000-hp units will be employed in this plant, the generators supplying a current of 11,000 volts directly from the armature windings. The current designed for transmission to Toronto will be raised to 60,000 volts and transmitted over a line about 90 miles long, which will be constructed probably of bare aluminum cable on account of its comparative lightness, thus requiring fewer poles. The power can be supplied by either the Canadian or the American stations, according to the arrangements of connections between the plants.

The president of the Canadian Niagara Power Company is Mr. W. H. Beatty, Mr. William B. Rankine is vice-president and treasurer, and Mr. A. Monro Grier, K. C., is secretary and solicitor. This company is associated with the Niagara Falls Power Company, whose plant is on the American side. This new Canadian plant will have a feeder forebay 300 ft. long and 280 ft. wide, the depth being 15 ft. at low water. A five-span stone arch bridge 60 ft. wide will span this forebay; each arch, which will cover about 50 ft. and be built of steel and concrete, will carry two tracks for the electric railway of the International Railway Company, as well as a highway and sidewalks.

The wheel pit which will contain the penstocks and turbines is to be 570 ft. long and 21 ft. wide, with a total depth of 170 ft. The method adopted for the power development of the Horseshoe Falls by the Canadian Niagara Power Company, is similar to that of the Niagara Falls Power Company on the American side. The forebay supplies the water to a wheel pit nearly 200 ft. deep, which contains the turbines and penstocks, while a tunnel is employed to carry the water away from the turbines as a tail race.

The wheel pit of the first section of the power house constructed will be 270 ft. long, and about three-fourths of the depth has already been reached by the contractors, Dawson & Riley, of St. Catharines, who are also constructing the large forebay. From the north end of the wheel pit a 16-ft. canal 500 ft. long is to be constructed as an ice run, and as several feet fall with be allowed, a good current will result between the mouth and the entrance; gates will regulate the flow from the forebay. Contractor A. C. Douglass is making good headway with the tunnel, shaft and portal, the former being 18 ft. wide and 25 ft. high. This tunnel is nearly half a mile in length and will be lined with brick and concrete, several million brick being employed in this work.

The penstocks in the power plant of the Canadian Niagara Power Company will be a trifle over 10 ft. in diameter and the main shaft, which connects the turbines and generators running vertically in the wheel pit, is to be 40 in. in diameter.

The first installation will consist of five turbines built after designs by Escher, Wyss & Co., of Zurich, Switzerland, each having a capacity of 10,000 hp, under a fall of 158 ft. Eventually this will be increased to 110,000 hp by the addition of six more such turbines. It is stated that the weight of all of the revolving parts will be carried by a water balancing piston, the lower wheel forming another balancing piston. The turbines are estimated to use each 885 cubic feet of water per second. The turbines are to be directly connected to three-phase vertical generators of the internal revolving field type. These machines are being constructed by the General Electric Company and will supply three-phase currents at 11,000 volts and 25 cycles. The turbines will drive the generator fields at a speed of 250 r.p.m., the weight being about 80 tons. The power house is to be equipped with two electrically-driven cranes of 100,000 pounds capacity each.

The power plant of the Canadian Niagara Power Company is located about a third of a mile above the Horseshoe Falls in Victoria Park. This company is closely allied to the Niagara Falls Power Company and its plant is similar in construction to that of this company on the American side, including an intake canal, a discharge tunnel and wheel pits nearly 200 ft. deep.

While the generators on the Canadian side will be of the three-phase type and of 11,000 volts, and those on the American side are two-phase machines supplying current at 2,200 volts, still provision is made for operating the entire system in parallel on both sides of the river.

For the transmission of power to Toronto, which is nearly 90 miles from the power house of the Canadian Niagara Power Company, 60,000 volts will be employed and several hundred cities and small towns will be served by the transmission line through this section of the Province of Ontario.

The 11,000-volt, three-phase currents from the power house will be utilized at this voltage for power distribution in and about the Canadian city of Niagara Falls, and the current may also be used on the American side if desired, as the two power houses will be connected by triple conductor cables carried over the Niagara River on the upper arch bridge.

The American two-phase generators and the Canadian three-phase generators will be arranged to be connected in parallel by means of the Scott system of two-phase, three-phase, step-down transformers. By this arrangement the two-phase, 2,200-volt current from the American power plant can be raised to 11,000 volts and changed to a three-phase current at the same time by the step-up transformation and transmitted across to the Canadian plant through triple-conductor cables on the bridge. It can thus be used directly in parallel with the Canadian high-pressure machines when they require assistance for the local distribution, or it can be raised by the step-up transformers to 60,000 volts for helping out on the long-distance transmission line if necessary.

In the same way the Canadian machines may be made to assist on a heavy load on the American side by a reverse transformation, supplying the power users on the American side in parallel with the two-phase machines at 2,200 volts, or raised to 22,000 volts, three-phase for the American transmission lines to Buffalo, Tonawanda or Lockport, if desired.

The Canadian three-phase, 10,000-hp generators are similar in construction to the new generators to be used on the last five units of power house No. 2 on the American side, both having internal revolving fields and external stationary armatures.

The Ontario Power Company will install its plant on the Canadian side below the falls, carrying the water over the bank to the turbines below by a system similar to that of the Niagara Falls Hydraulic Power & Manufacturing Company on the American side.

It may be of interest to note the difference in construction of the electrical apparatus, including the generators, switchboards and other apparatus in these various plants, due largely to the different methods employed in developing the energy by the hydraulic turbines. The owners of the Niagara plants above the falls using the vertical turbines must necessarily employ vertical electrical generators, while those power companies using horizontal shaft turbines below the falls utilize electrical generators very similar to those employed in steam engine practice for large power plants.

An accompanying illustration shows the hydraulic arrangement of the penstocks and horizontal turbines, which are directly connected to both alternating and direct-current machines having horizontal shafts and armatures as installed at the present power house of the Niagara Falls Hydraulic Power & Manufacturing Company.

In the power plant of the Niagara Falls Hydraulic Power & Manufacturing Company, below the falls, the generator supplying current for the Buffalo & Niagara Falls Electric Light & Power Company, which is located in the power house below the cliff on the American side, is a single-phase machine of high frequency. It has a capacity of 700 kw and generates current at 125 cycles and 2,200 volts. This machine is direct-connected to one end of the turbine shaft, which drives it at a speed of 250 r.p.m.

A General Electric 14-pole, direct-current machine is directly driven by the turbine shaft supplying a current of 5,000 amp. at 175 volts, which is used for electrochemical work in the chlorate of potash plant. This machine has a capacity of 875 kw, or about 1,200 hp, and the current is conducted over aluminum cables, a portion of which is bare and the balance well insulated where leakage is liable to occur.

Of the four Leffel turbines supplying 2,250 hp each, three are directly connected to six direct-current multi-polar machines for supplying current to the Pittsburg Reduction Company for use in the electric furnaces for producing aluminum. The current is conducted on aluminum bars up the side of the 11-ft. penstock to the aluminum building on the upper bank.

The fourth Leffel wheel drives two direct-current machines which supply current for various power users as well as to the Lewiston & Youngstown Electric Railway and the Niagara Falls & Lewiston

or Great Gorge road. A 200-kw generator of the General Electric, direct-current, shunt-wound type supplies current at 135 volts for use in the manufacture of chromium by the Alloy Smelting Company. This generator is driven by a turbine receiving its water from the 8-ft. penstock.

Of the five Jonval-Geyelin turbines supplied from the 11-ft. penstock and ranging in capacity from 2,300 to 3,000 hp, two are directly connected to 750-kw multi-polar generators supplying current of 3,000 amp. each at 300 volts. The current from these machines is used for the reduction of aluminum by the Pittsburg Reduction Company.

Three 1,000-kw machines are operated by Jonval-Geyelin turbines and deliver current to the plant of the Acker Process Company, and a 5,000-amp. generator supplies current to the National Electrolytic Company. The current generated by the machines driven by the new turbines built by the I. P. Morris Company will be used by various manufacturing concerns, including the Pittsburg Reduction Company, the Acker Process Company and the National Electrolytic Company. These and other electrochemical works will also absorb much of the power of the new station, which is to be built near the Whirlpool Rapids, to take water from the enlarged Schoelkopf power canal.

The power plant below the cliff installed by the Niagara Falls Hydraulic Power & Manufacturing Company, while developing a large amount of power and generating many thousands of kilowatts of energy, is not to a great degree a power transmission generating station. The current is very largely a direct current and utilized in the immediate neighborhood by various factories for motive power and by numerous electrochemical works for their various processes requiring current for electrolytic cells and electric furnaces.

The power transmission plants, strictly speaking, are those above the falls owned by the Niagara Falls Power Company and the Canadian Niagara Power Company. Whether the current generated at the power house below the falls on the Canadian side by the Ontario Power Company or that supplied by the new power house on the American side near the Whirlpool Rapids, will be transmitted to a distance to any considerable amount is as yet unknown. There is no question but that there will be a continual demand in the neighborhood of the City of Niagara Falls for a vast amount of electric power for new electrochemical and other industrial plants during the next decade.

The Niagara Falls Hydraulic Power & Manufacturing Company has recently acquired a large area of land in the north end of the City of Niagara Falls where numerous factories will be constructed, and undoubtedly most of the available power of this company will be utilized in the immediate vicinity of the "Power City."

The power development at Niagara under way is well on towards half a million horse-power and even at the present time about $35,000,000 capital has been raised for this great work. It is stated that the plans of the Ontario Power Company provide for a development finally of 400,000 hp, and the construction of a plant for 50,000 hp is now under way.

The new power company which has entered the field and secured a franchise from the State of New York for the development of 200,000 hp, is said to have an abundance of capital for the work. This company is known as the Lower Niagara River Power Company, and it is stated that the work on this company's installation will soon begin.

Wireless Newspaper on Land.

The Los Angeles (Cal.) *Times* says: "The only daily newspaper in the world publishing sure-enough dispatches transmitted by wireless telegraph had its birth yesterday morning (March 25) at Avalon, Santa Catalina Island. The event is a unique one in the history of journalism and marks the beginning of an epoch in the dissemination of news in isolated places. The name of the infant journal is the *Wireless*, appropriately so called on account of the method by which it receives the news of the busy world. The unique sheet begins its career in the shape of a three-column folio, the exact size of the pages being 11 x 8 in. In this convenient form is crowded, in addition to the local news of Avalon, an epitome of the local and general news appearing simultaneously in the *Los Angeles Times*, thus giving the residents of the island and visitors to its lovely shores a comprehensive synopsis of all the principal news of the world hours before the arrival of the steamer from the mainland with the Los Angeles morning paper."

Manufacture of Electrical Conductors in Russia.

Our Russian contemporary, *Electritcheskij Wiestnik*, of St. Petersburg, in a recent issue comments upon the present situation in Russia with respect to the manufacture there of electrical conductors. The occasion of its comment is a letter forwarded for publication by Messrs. Felton & Guillaume, known also as the Reben Manufacturing Company, of St. Petersburg, which was called forth by some statements made by the American Consul at Odessa, Mr. T. Chinan, criticising the slowness of electrical development in Russia. Referring to the Consul's remarks on the production of electrical conductors and cables, the letter says that the Reben Manufacturing Company and also the Siemens & Halske Company produce conductors and cables of excellent quality, but it is acknowledged that the exportations from abroad are very large.

The editor remarks that the letter does not answer the question, Why, in spite of the good quality of Russian cables, are such large quantities bought abroad? He also incidentally says that the American Consul neglected to mention the Petilchef Works at St. Petersburg and the Koltchugine Works at Moscow, which have quite large outputs. In answer to the question, it might be said that Russian manufacturers do not make all lines of conductors and cables or that they are not able to produce the necessary amount to meet the Russian demand. It is, however, a well-known fact that they do manufacture all forms of conductors and cables and that the capacity of their plants is in excess of the demand. The real difficulty lies in the fact that manufacturers are handicapped by conditions over which they have no control. Copper and other raw materials required are subjected to a heavy taxation which more than offsets the import duty on the manufactured material. This reason, as well as others, causes orders to go to foreign countries, and those given to Russian manufacturers are at figures more apt to result in a loss than a gain. To other adverse conditions should be added the high cost of freight transportation in Russia. In Austria and Germany manufacturers are allowed considerable reduction on carload shipments, and they frequently ship in a roundabout way over longer distances in their own countries in order to shorten the transportation over Russian railroads. On the other hand, the Russian railroads place electric conductors and cables in the high-tariff class of merchandise, and allow no reduction in rates, no matter what may be the quantity shipped.

Still another adverse condition is in connection with the supply of telephone and telegraph conductors. The principal European governments own the telegraph and telephone services, and naturally purchase material required in their own countries. The manufacturers in these countries then sell their surplus to foreign countries at a low figure, sometimes even less than actual average cost to them, in which case, however, they derive an advantage through being able to operate their factories at normal capacity. In Russia where the telephone service is under private ownership, the companies naturally wish to purchase their material at the lowest figure without reference to whether it is made in Russia or abroad. This was recently illustrated in the course pursued by the syndicate which obtained a telephone franchise in St. Petersburg.

The editor considers that the taxation on raw materials, as well as the tariff on manufactured products, should be so regulated as not to close the market to Russian manufacturers, while leaving it open to foreigners. He believes that such a revision may soon be expected. A short time ago a new tariff scheme was proposed, which provides duties much higher for manufactured products, but unfortunately also higher for raw material. That the high quality of Russian material is recognized at home is shown by a large order recently given to the Reben Works for all the conductors to be used in connection with the new telephone exchange at Riga, and for the conductors for the new electric light plant at St. Petersburg.

Third Rail in New York.

It is reported that the Manhattan Elevated in New York may try the hooded third rail in place of the unprotected form. Alderman Downing has presented a resolution to the board asking the Corporation Counsel to draft a law compelling railroad companies to devise a system for the use of covered third rails. The matter was referred to the Committee on Railroads.

Electrically-Operated Irrigation Plant in Utah.

A detailed description appeared in these columns some months ago (October 25, 1902) of a large irrigation plant on the shores of Utah Lake, operated by induction motors. The plant has been in operation now for some months, and from the first day has been of immense benefit to the farming community which it serves. By its means a large beet crop has been saved, and a third alfalfa crop secured. The accompanying illustrations give views of the interior and exterior of the pump house.

There are four Byron Jackson centrifugal double-suction pumps

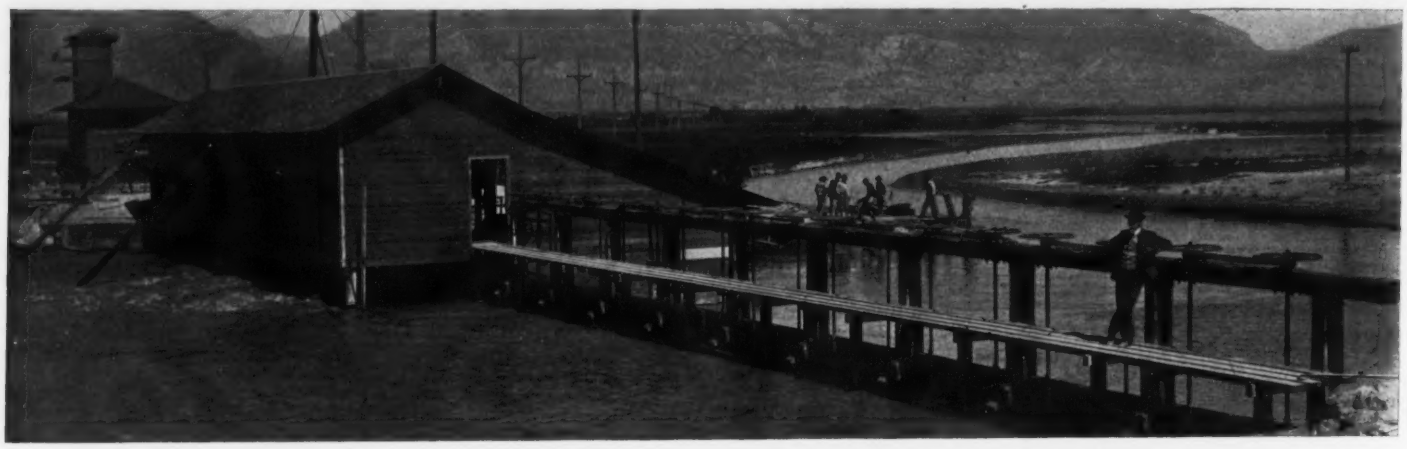


FIG. 1.—GENERAL VIEW OF WATER PUMPING PLANT FOR IRRIGATION.

in use, driven by the same number of Westinghouse induction motors of 100 hp each. The pump, as shown in the illustration is 9 ft. in diameter, with an outlet 48 in. in diameter. The pulleys attached to the pumps make some 200 r.p.m. and each has a diameter of 6 ft.

The pumps are placed on a platform on piles in a channel of the river 300 yards from the lake outlet. The water is forced through a dam constructed across the river, and the pumps raise the river water at their outlet about 3 ft. higher than it is at the intake. Large gates stop the water from flowing back into the lake.

The pumps supply water for about 30,000 acres of land, which would be worthless without them. There are those who express fear that the lake cannot stand the constant drain, and that the water supply will be exhausted; but while it is thought that the fall of the level in the summer may be four, five or possibly six feet, it is

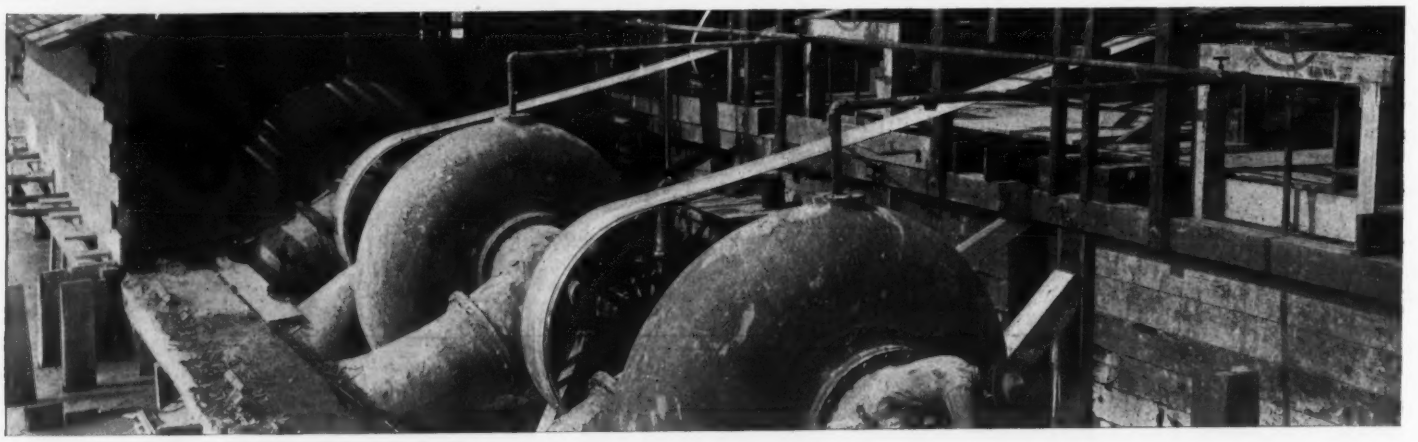


FIG. 2.—VIEW OF PUMPS, UTAH LAKE PUMPING PLANT.

claimed by those interested in the scheme that the winter will make up for all the decrease. The lake surface is 375 square miles, and it is claimed that three-fourths of the loss is caused by evaporation and only one-fourth by irrigation; and that by lessening the surface of the water a large percentage will be saved.

Institution of Electrical Engineers.

Secretary McMillan, of the English Institution of Electrical Engineers, writes that the library and offices or the Institution will be hereafter at 92 Victoria Street, London, S. W., where all communications should now be addressed.

Effect of Grounding the Neutral on an Alternating-Current System.

The Chicago Electrical Association had another very successful dinner at the Albion Café, Pullman Building, Chicago, Friday evening, April 3, over 100 being present. The subject for discussion was: "The Effects Produced by Grounding the Neutral on Alternating-Current Systems." A paper was presented by G. M. Eastman, who has charge of the testing department of the Chicago Edison Company. Mr. Eastman first took up the general mathematical principles involved as laid down in the paper presented by J. D. Nies at a previous meeting of the association and published with some additions by the author in ELECTRICAL WORLD AND ENGINEER of April 12, 1902. This paper has almost become a classic on that subject. Mr. Eastman, after a discussion of the general principles, proceeded to figure out some concrete examples from the overhead and underground lines of the Chicago Edison Company, and showed how much excessive pressure above the normal working voltage might arise in certain cases where the neutral was not grounded; the conclusion being in every case that arises in practice that the neutral of a four-wire, three-phase, alternating-current system should be grounded. The contents of Mr. Eastman's paper will be given more completely in a later issue.

J. D. Nies, in discussing the paper, spoke of Mr. Eastman as having been one of the first champions of the practice of grounding the neutral. While at first sight it would seem dangerous to deliberately place a ground on a high-tension alternating system, thereby producing the full-phase voltage between any one of the wires and the ground, it is now conclusively demonstrated that an accidental ground on an underground system might cause a voltage much in excess of the regular voltage. With the neutral not grounded permanently, an accidental ground on any one of the phase wires, if not inductive, might give rise to a potential 83 per cent. above the normal working voltage. But if the accidental ground were of the swinging kind, such as would draw an arc, and hence be of the nature of an inductive resistance, the rise in voltage due to the ground might be much higher. If the ground were in the primary

coils of a transformer, it was possible to get a voltage of four or five times the regular pressure of the system. It was always better to ground the neutral.

President Woodworth spoke of the difficulty at first in convincing some of the authorities in charge of local legislation or of the framing of underwriters' rules, that true safety lay in grounding the neutral; and he pointed to the fact that it had actually been proposed to forbid by law the grounding of the neutral in the City of Chicago.

Mr. D. W. Roper, of St. Louis, was called upon to tell of the practice of the Missouri Edison Company in regard to grounding on alternating-current lines. He said that his company operated only a single-phase, alternating-current system. The various alternators were not operated in parallel, but one side of each alternator was connected to a common bus-bar. This, of course, gave something in the nature of a star-connected multiphase system, as the current of the various alternators occupied various angles with reference to the common bus-bar. This common bus-bar was now connected through a non-inductive resistance to ground. Before this bus-bar was grounded, a lightning arrester discharge between any one of the mains and grounds was likely to cause an excessive potential between the common bus-bar and ground, so that the arrester on this side would discharge, causing a temporary short circuit. A non-inductive resistive in the shape of a barrel of water was connected between the common bus-bar and ground. This resistance amounted to about 20 ohms on the 1,200-volt, single-phase system. After the proper resistance was determined in this way, a permanent non-inductive resistance was installed. This resistance also serves a useful purpose in the operation of a ground detector. A transformer is connected in shunt across the terminals of this resistance. Ordinarily not enough current flows between the common bus-bar and ground to light a lamp in the secondary of this transformer. If a ground should come on the non-grounded side of any one of the feeders, this lamp would be lighted, because of the rise in potential across the terminals of the resistance.

Mr. H. B. Gear told of the practice of the Telluride Power Transmission Company in Utah. This company has about 300 miles of three-phase, 4,000-volt line, much of which is aluminum. The transformers are star-connected and the neutral grounded. An interesting thing about this line is that the lagging current due to the inductive load imposed by the motors does not compensate for the leading current caused by the condenser capacity of the line. The company has two plants about 90 miles apart, in parallel. As illustrating some of the inconveniences of having so large a leading current, Mr. Gear mentioned one incident where, with the ordinary connected load, it was necessary to operate one of the idle generators in the power house as a synchronous motor, to give a lagging current to the line.

Mr. Carl Swartz was called upon to state the practice in Russia and in Caucasia. He said the larger central stations in Moscow and St. Petersburg used delta-connected transformers, one other station was named employing star-connection with grounded neutral.

Mr. G. H. Lukes, superintendent of the North Shore Electric Company, Evanston, Ill., remarked on the St. Louis practice as being economical in cost of switching apparatus. As the voltage of an installation is increased the cost of switching apparatus and switchboard installation increases very rapidly. By using a common bus-bar for one side of the system and grounding that bus-bar, single-pole switches could be used everywhere, and the switching apparatus reduced very much in cost. On pole lines, also, the grounding of one side was an advantage, because the grounded lines could be kept near the pole, leaving the live lines for the outer ends of each cross arm.

Mr. Blanc, responding to a request to give the results of his observations in California on grounding the neutral, said that it was a practice generally endorsed there, both the Standard and Bay County's immense transmission systems being operated with a grounded neutral. One of the first transmission plants in Germany started to operate with star-connected transformers and a grounded neutral; but the government found that this interfered with their grounded-line telephones, and prohibited the practice of grounding.

Mr. Peter Junkersfeld, regarding the practice of omitting the switches in any circuits which are grounded, said that on some of the recent work of the Commonwealth Electric Company on the four-wire, three-phase system, switches had been put on the three outside or phase wires only, leaving the neutral permanently connected to ground without switches. He considered papers along the lines of Mr. Eastman's of great value, by demonstrating that the grounding of the neutral is not only permissible, but absolutely necessary to the greatest safety of operation. When a new practice of this kind is inaugurated it is sometimes claimed that the operating company is adopting the new practice because of some financial benefit it is to derive from it, and that it is a detriment to the general public. Mr. Eastman had shown that it was safer for the public, for the employees of the company and for the apparatus, to have the neutral grounded.

Cable Code Vocabulary.

At the last meeting of the New York Chamber of Commerce, the Committee on Foreign Commerce and the Revenue Laws also presented a short report with reference to the compulsory use of an official cable vocabulary for commercial purposes. It was as follows:

Your Committee on Foreign Commerce and the Revenue Laws beg leave to present the following preamble and resolutions, and to move their adoption:

"*Whereas,* It is reported that an effort will be made at the conference of International Telegraph Lines in London, on May 26, 1903, to put into compulsory use in cable telegraph messages the so-called 'official vocabulary' of cable code ciphers prepared under the direction of the International Telegraphic Bureau; and

"*Whereas,* Such official vocabulary is inadequate for commercial business, and not adapted to existing conditions; and

"*Whereas,* The enforced use of such official vocabulary and the exclusion of cable code systems now in use would entail serious expense, inconvenience and labor upon commerce; therefore, be it

"*Resolved,* That the Chamber of Commerce of the State of New York again enter its protest against the compulsory use of an official vocabulary in cable telegraphy; and be it further

"*Resolved,* That the Committee on Foreign Commerce and the Revenue Laws be instructed to enter into communication with other commercial bodies, both in this country and in other parts of the world, for the purpose of bringing every possible influence to bear to cause a reconsideration of the proposed plan for the compulsory use of the 'official vocabulary' in cable correspondence."

This report was signed by Gustav H. Schwab, Isidor Strauss, S. D. Webb and George F. Vietor.

Wireless Telegraphy Across the English Channel.

The Northern of France Railway Company, it is stated, has decided to install wireless telegraphy on its Dover-Calais cross-channel steamships. A station will be erected at Calais harbor. Some time ago an effort was made to introduce wireless telegraphy on all the packets running between Dover and Calais, but the obstructions of the English postal authorities prevented a receiving station being erected on their side of the Channel. Even now the French mail packets, like the Belgian boats, will be unable to communicate with Dover, however necessary a message may be, as in the case of a break-down similar to that which befell the *Pas de Calais* not long ago. The present English policy, therefore, is "not to talk back."

Cheap Chemical Alcohol.

Advices received by the State Department at Washington from United States Consul Haynes at Rouen, France, throw more light on the new process that has been discovered by which alcohol may be produced by chemical synthesis. It is predicted that the cost of such production can be reduced to less than ten cents a gallon. Thus far the cheapest alcohol produced has cost nearly twenty cents a gallon. At this price Germany produces quantities of alcohol, potatoes being used as the vegetable base. By the French process no vegetable matter is employed. From carburet of calcium—a direct combination of carbon and hydrogen in the electric arc—acetylene is obtained. Sufficient hydrogen then is added to produce ethylene and by combining water with ethylene alcohol is obtained. While the cost of alcohol by the new process has not yet been reduced much below its cost as produced from vegetable matter, it is predicted with confidence by eminent French chemists that in the near future it may be produced by the new process at a cost of about half that which Germany pays to obtain it from potatoes.

Sheet Steel for Static Transformers.

BY WALTER S. MOODY.

THOSE who are at all familiar with the subject know in a general way that there has been a great improvement in the efficiency, safety and life of transformers since they were first used commercially. It is doubtful if many fully appreciate how very great the change is or the principal reason that has made the improvement possible. Let us look back for a moment to what must, in electrical history, be considered ancient records to ascertain what the advance has really been.

In order to make the comparison simple we must have data on one size of transformer extensively used through the period covered. If we go back 15 years this necessitates the selection of what to-day seems a very small unit.

The following data apply to 2½-kw transformers. The figures for each period are the average of tests made at that time on several different makes, and in no case represent a single transformer or make of transformer. They are therefore, fairly representative of the average commercial produce of the leading manufacturers of the time.

Time (years back)	15	10	5	Present.
Total losses in watts	190	125	103	92
Full load efficiency	93%	95.5%	96%	96.4%
Temperature rise full load 8 hours....	100°C.	80°C.	60°C.	40°C.

During the period covered commercial frequencies have dropped from 125 cycles or higher to 60 cycles. The first two cases above cited are based on transformers designed for the higher frequency. The last two were designed for the lower frequency, but all figures apply to operation at 125 cycles, for uniformity. The question is, how has it been possible, without material change in cost, to so greatly improve transformers that those made now have less than half the losses and temperature rise of those made 15 years ago?

Analysis of the designs does not show any great change in the effectiveness with which material is used. The dimensions of the coils and core and their relative weights were almost as well chosen in the best transformers made ten years ago as in those of to-day.

Much has been learned as to the best insulating material and its most effective use, resulting in transformers being more safely insulated and yet having a much larger percentage of the winding space filled with solid copper. These changes are of comparatively minor importance, however, in their effect on efficiency. Commercial copper has not changed appreciably in its conductivity. Therefore, it does not enter as a factor in the case.

This leaves us nowhere to look for the improvement, but in the iron used to form the magnetic circuit, and it is right here that we do find practically all necessary to account for the transformer of to-day having less than half the losses of those made in the past.

The early manufacturers of electrical apparatus found that different lots of iron varied greatly in hysteratic and eddy losses and that, in general, the former could be reduced by having the iron soft, but why one lot was better or worse than another no one could say.

The art of rolling thin sheet iron was then in a rather elementary state in this country and the extreme variations in the magnetic properties of various lots of iron as received from the mills induced some manufacturers to investigate foreign products. It was found in so doing that a mild sheet steel produced in England for tin plate was much superior in mechanical properties to anything that was then produced in this country, besides being better mechanically.

Extensive use of this material left much to be desired, however. Magnetic variations, while less pronounced than in the American-made iron, were still very great even after the material was reannealed by the transformer manufacturer. There was no assurance that a mill that gave good material in one shipment would do so in the next. The electrical manufacturer was, therefore, never sure of his finished product and was constantly in search of some mill that would give him better iron. The search much resembled the groping of a blind man, as neither the transformer maker nor the steel manufacturer knew what was necessary to obtain the desired result.

Many are to-day still continuing the hopeless search, but the progressive man appreciates that he could never produce satisfactory electrical apparatus until he had steel that was as definite a substance magnetically as copper and insulating materials are electrically.

Little progress was possible so long as the supply had to be obtained from abroad. The foreign mills were too inaccessible and their management too conservative to admit of the study and changes necessary for advancement. Fortunateiy, however, the rolling of sheet steel for tin plate and other purposes was undertaken in this country about ten years ago, and all know the rapid progress that was made, resulting in the United States producing practically all its own sheet steel. With this advance in the art of making good sheet steel for mechanical purposes came the opportunity for the electrical engineer and the sheet steel manufacturer to work together towards obtaining the best possible material for magnetic purposes. The problem was not an easy one and required joint study on the part of the electrical engineer, metallurgist and practical sheet steel manager. The gratifying result is that to-day it is possible to cover by detailed specifications every step in the process of the manufacture of magnetic steel so definitely that the carrying out of such instructions will insure a product in which the quality of steel in different transformers does not vary 5 per cent. from an established standard. The writer has before him records of tests on thousands of transformers produced during the last two or three years, the cores of which were built from steel manufactured in different mills, but to the same specifications, in which such uniformity is shown.

It is not within the scope of this article to attempt to explain in detail how this result is obtained. Briefly it may be stated, however, that the chemical composition, the mechanical processes to which the steel is subjected during its manufacture, and last and most important of all, the heat treatment from the beginning to the end of the process, have a direct and important bearing on the product.

The chemical composition need not differ greatly from that of sheet steel rolled for mechanical purposes, and a very considerable latitude in composition is allowable provided the heat treatment is changed to agree with the composition. It evidently is desirable, however, to maintain a uniform practice with reference to heat treatments, and as a slight change in composition necessitates a corresponding change in heat treatment, it follows that once having selected a composition it is desirable to hold to it as closely as the present knowledge of steel manufacture admits. In this respect as well as in the mechanical workings, however, no greater care is necessary than in producing high-grade steel designed to have definite mechanical properties. In the heat treatment, on the other hand, the requirements are much more severe.

It has been a well-established fact for several years that the mechanical properties of steel depend very largely on the arrangement of its molecules. These may be in an amorphous or in various crystaline forms. By studying this structure with the aid of a powerful microscope the metallurgist can with considerable accuracy tell the previous mechanical and heat treatments which produced the structure as shown and in this manner can decide whether the steel is suitable for a given purpose or not.

Similar investigation has more recently demonstrated that much can be learned about the magnetic condition of steel in the same manner. It is found to be a fact that in order to get a steel of a given composition into a definite magnetic condition that it is necessary to control the temperature throughout the various processes of manufacture with far greater exactness than is necessary in obtaining equally satisfactory results with steel desired for mechanical purposes. The method of determining temperature by color, crude even when performed by an expert, must give way to some of the various forms of pyrometer capable of accurately measuring within five to ten degrees temperaturs between 700 and 1,000° C.

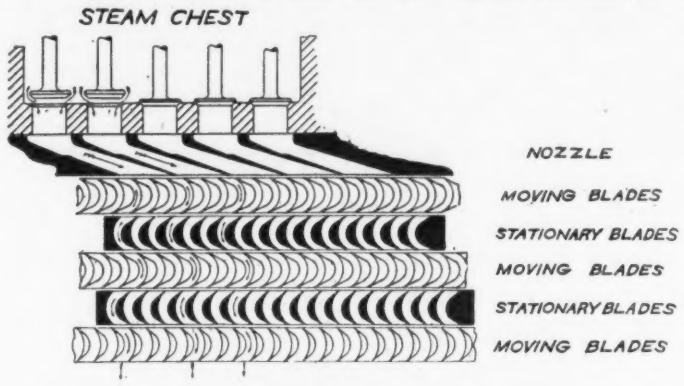
Furnaces must be used in which perfect control of the heat is possible and in which uniform distribution of heat throughout the furnace is assured. The design of furnace must be such that the pyrometer used can take not only the temperature at one point, but at many points so that any failure of the furnace to maintain uniform temperature may be promptly and accurately known.

In other words, the structure of steel can only be put in that condition in which it has the lowest coefficient of hysteresis by the aid of a furnace whose temperature is under more perfect control than has heretofore ever been possible except it may be in laboratory experiments. Especially is this true if the steel is to remain in this condition permanently when subjected to the moderate increase of temperature usual in transformers; that is, if freedom from so-called "aging" is to be assured.

Apparently there is reason to hope for still further reduction in the hysteresis coefficient, although present results are probably approaching the limit. Such improvements as may still be accomplished will in the opinion of the writer be the result of still greater uniformity in composition and more perfect control of high temperatures than has so far been practicable.

The Curtis Steam Turbine.*

THE development which this paper describes is based upon the original theories and inventions of Mr. C. G. Curtis, of New York, whose ideas were first made the subject of patent application about 1895. Since that time these inventions have been the subject of experimental investigation at Schenectady under the direction of Mr. Curtis and of the General Electric Company's engineers; the object of these experiments being to establish data and laws which would form a basis for the correct design of commercial apparatus. The difficulties of such an investigation are very great. All new facts must be established by the test of different machines or parts which are difficult and expensive to produce. About two years ago the results of these experiments gave us data which showed great commercial possibilities, and since that time work has gone on on a large scale in the production of commercial machines. The contracts for these machines now aggregate 230,000 hp in turbine-driven electric generating units, the largest size so far built being 7,500 hp. Thus a great industry has been brought into existence in a very short time, and since the work has all been done in one



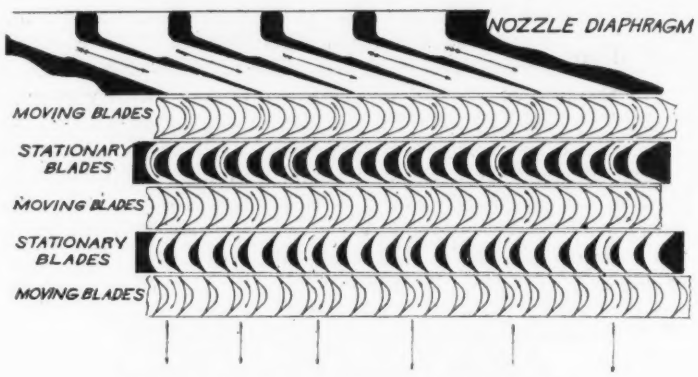


FIG. 1.—DIAGRAM OF NOZZLES AND BUCKETS.

place and by a few persons very little information concerning it has reached the public. This paper is the first printed matter which has appeared on the subject.

The reason for this immense demand and production without publicity and in so short a time, is that the improvements effected are radical in economy, simplicity and efficiency of action.

All improvements in prime movers are of great importance to the engineering world. The steam turbine is destined to effect the first really great improvement since the days of Watt, and the forms of Curtis turbine here described make the first great stride in advance of other steam engines.

Every efficient steam engine must provide means by which a fair proportion of the expansive force of steam can be converted into useful work. In the engines of James Watt and his successors this result is accomplished in various degrees by the application of pressure from the steam to moving pistons. In steam turbines the expansive force imparts motion to the steam itself, and this motion is given up to a revolving part by impacts of the moving steam upon it.

The idea of the steam turbine is quite simple, and is similar to that of the water turbine or impulse wheel. The practical difficulty which has heretofore prevented the development of good steam turbines, lies in the very high velocity which steam can impart to itself in expansion, and the difficulty in efficiently transferring this motion to wheels at speeds practicable for construction or practical use. Steam expanding from 150 lbs. gauge pressure per square inch into the atmosphere is capable of imparting to itself a speed of 2,950 ft. per second, and if it is expanded from 150 lbs. gauge pressure into a 28-in. vacuum it can attain a velocity of 4,010 ft. per second. The spouting velocity of water discharged from a nozzle with 100 ft. head, is 80 ft. per second. These figures illustrate the very radical difference of condition between water turbines and steam turbines. In both water and steam turbines the theoretical condition of maximum economy exists when the jet of fluid moves with a velocity equal to about twice that of the vane against which it acts. In water wheels this relation is easily established under all conditions, while with steam the total power produces a velocity so high that the materials available for simple wheels and vanes are not capable of sustaining a proper speed relation to it under practicable conditions.

Before the appearance of the Curtis turbine two practical methods of accomplishing fair economy had been devised, namely, the turbines of Carl De Laval, of Sweden, and of Hon. Charles Algernon Parsons, of England, both of whom were brought out more than fifteen years ago.

In the De Laval turbine, the total power of the steam is devoted to the production of velocity in an expanding nozzle which produces velocity very efficiently. The jet so produced is delivered against a set of vanes on a single wheel which, by an ingenious construction and method of suspension is adapted to operation at a very high peripheral velocity. The very high rotative speed which this construction entails is made available for dynamo driving by very perfectly made spiral-cut gears which effect a ten-to-one speed reduction. The peripheral velocity of the wheel in the largest De Laval tur-

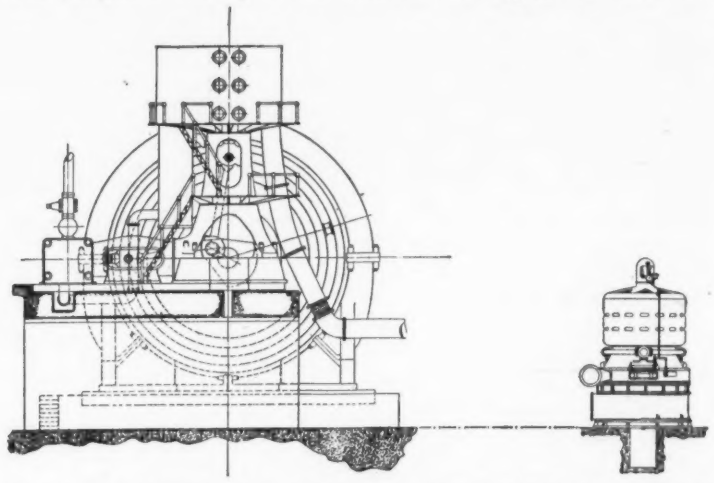


FIG. 2.—COMPARATIVE SIZES OF 5,000-KW CORLISS ENGINE AND 5,000-KW CURTIS TURBINE.

bines is about 1,200 ft. per second, while the velocity which energy can impart to steam is over 4,000 ft. per second. Thus the wheel falls far short of the theoretically economical speed.

In the Parsons turbine the steam is carried in an axial direction through the space provided between a succession of internal revolving cylinders and external stationary cylinders which enclose them. Both the internal and the external cylindrical surfaces are covered by many successive circles of vanes so arranged that the steam has to pass alternately through rows of moving and stationary vanes. In passing through this turbine the steam never acquires a speed which approaches the velocity which it attains in the De Laval nozzle; but instead, moves along alternately, acquiring velocity by expansion, and partially giving it up by impact with the moving vanes.

Both of these turbines have attained some success, but neither, as thus far developed, affords sufficient advantage over the steam engine to cause any very rapid or radical change in engineering conditions.

The important disadvantages of the De Laval type are, that it is limited by the imperfections of high-speed gearing, that its efficiency is not particularly high, and that the design is not conveniently applicable to large sizes. The Parsons type is principally limited by the multiplicity and weight of its parts, and the high cost of construction.

The Curtis turbine retains some of the features of its predecessors,

* A paper read by L. R. Emmet before the American Philosophical Society, Philadelphia, April 2.

but introduces new ideas which make possible a much lower speed, less weight, fewer and simpler parts, higher economy, less cost, and other important advantages.

The general arrangement of a turbine generating unit of this type is shown by the drawings which accompany this paper. Its functions may be briefly described as follows, and are illustrated by the accompanying cut.

Velocity is imparted to the steam in an expanding nozzle so designed as to efficiently convert nearly all the expansive force, between the pressure limits used, into velocity in the steam itself. After leaving the nozzle, the steam passes successively through two or more lines of vanes on the moving element, which are placed alternately with reversed vanes on the stationary element. In passing successively through these moving and stationary elements, the velocity acquired in the nozzle is fractionally abstracted, and largely given up to the moving element. Thus the steam is first thrown against the first set of vanes of the moving element, and then rebounds alternately from moving to stationary vanes until it is brought nearly to rest. By this means a high steam velocity is made to efficiently impart motion to a comparatively slowly moving element. The nozzle is generally made up of many sections adjacent to each other, so that the steam passes to the wheels in a broad belt when all nozzle sections are in flow.

This process of expansion in nozzle and subsequent abstraction of velocity by successive impacts with wheel vanes is generally repeated two or more times, the devices for each repetition being generally

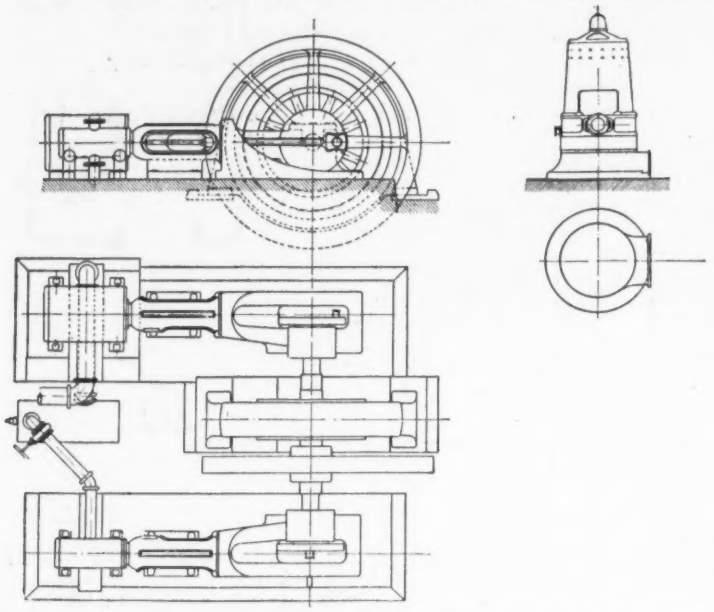


FIG. 3.—COMPARISON OF 500-KW CROSS-COMPOUND ENGINE AND 500-KW CURTIS TURBINE.

designated as a stage. There may be various numbers of stages and various numbers of lines of moving vanes in each stage. The number of stages and the number of lines of vanes in a stage are governed by the degree of expansion, the peripheral velocity which is desirable or practicable, and by various conditions of mechanical expediency.

Generally speaking, lower peripheral speeds entail more stages, more lines of vanes per stage, or both. Our general practice is to so divide up the steam expansion that all stages handle about equal parts of the total power of the steam.

The losses and leakages of the earlier stages take the form of more heat or more steam for the later stages, and are thus in part regained. Much water of expansion, which might occasion loss by re-evaporation, is drained out of each stage into that which succeeds it.

The governing is effected by successive closing of nozzles and consequent narrowing of the active steam belt. The cut shows part of the nozzle open and part closed; the arrows showing space filled by live steam. In the process of governing, the nozzles of the later stages may or may not be opened and closed so as to maintain an adjustment proportional to that of the first stage, which is always the primary source of governing. Some improvement of light load economy may be effected by maintaining a relative adjustment of all nozzles; but in many cases the practical difference in economy is not great, and automatic adjustment of nozzle opening in later stages is dispensed with in the interest of simplicity. In some machines an approximate adjustment is maintained by valves in later stages, which open additional nozzles in response to increase of pressure behind them. These are used as much for limiting the pressures in stage chambers as for maintaining the light load economy.

The principle of the Curtis steam turbine is susceptible of application to a variety of purposes. Within the scope of this paper

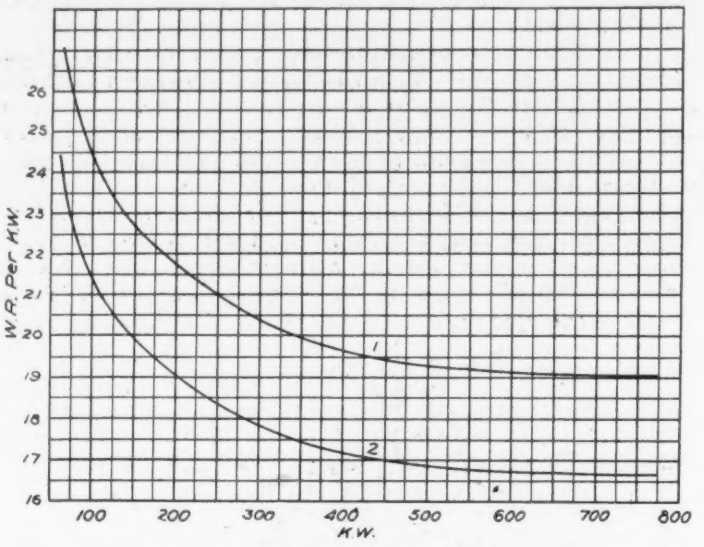


FIG. 4.—CURVES OF WATER CONSUMPTION OF 600-KW CURTIS TURBINE.

I intend to give only a general idea concerning existing designs for its application to electric generators. Its development, even for this purpose, is very recent, and will doubtless be subject to important future improvements. In its present state, however, it embodies many important advantages, as has already been stated. The most important of these advantages is the high steam economy which it affords under average conditions of service. This economy is shown by the accompanying curves, which are derived from actual tests of the first commercial machine of this type which was completed. This machine drives a dynamo of 600-kw capacity. The curves give its performance at a speed of 1,500 r.p.m., which is a safe and practical speed for commercial operation, and which corresponds to a peripheral velocity of about 420 ft. per second. The results, with superheat, given in these curves are not derived actually from tests of this turbine, but are plotted from data obtained on smaller turbines. They correspond to the results obtained on turbines of other types, and are undoubtedly reliable.

Fig. 4 shows the steam consumption of this machine in pounds per kilowatt-hour output at various loads and under the conditions stated, the lower curve giving the steam consumption at various loads with 150° superheat.

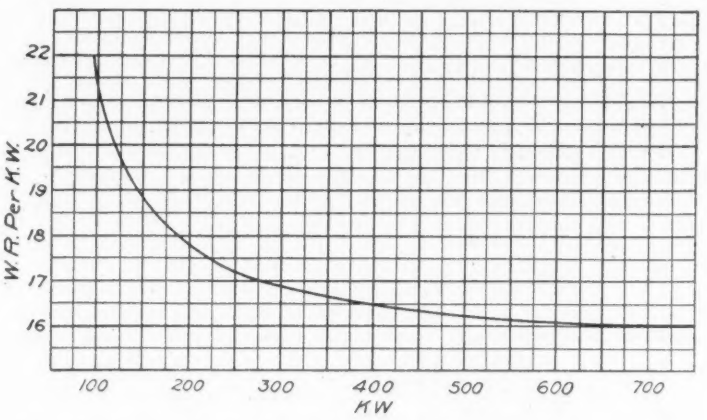


FIG. 5.—CURVE OF WATER CONSUMPTION OF 600-KW CURTIS TURBINE.

Fig. 5 shows the results which could be obtained from this turbine if it were operated with high pressure and a high degree of superheat, these conditions of operation being perfectly practical with the machine, while with steam engines the use of such high temperatures would with ordinary constructions be prohibitive.

The results shown by these curves are better than any heretofore produced by steam turbines of any make or size, and are very much

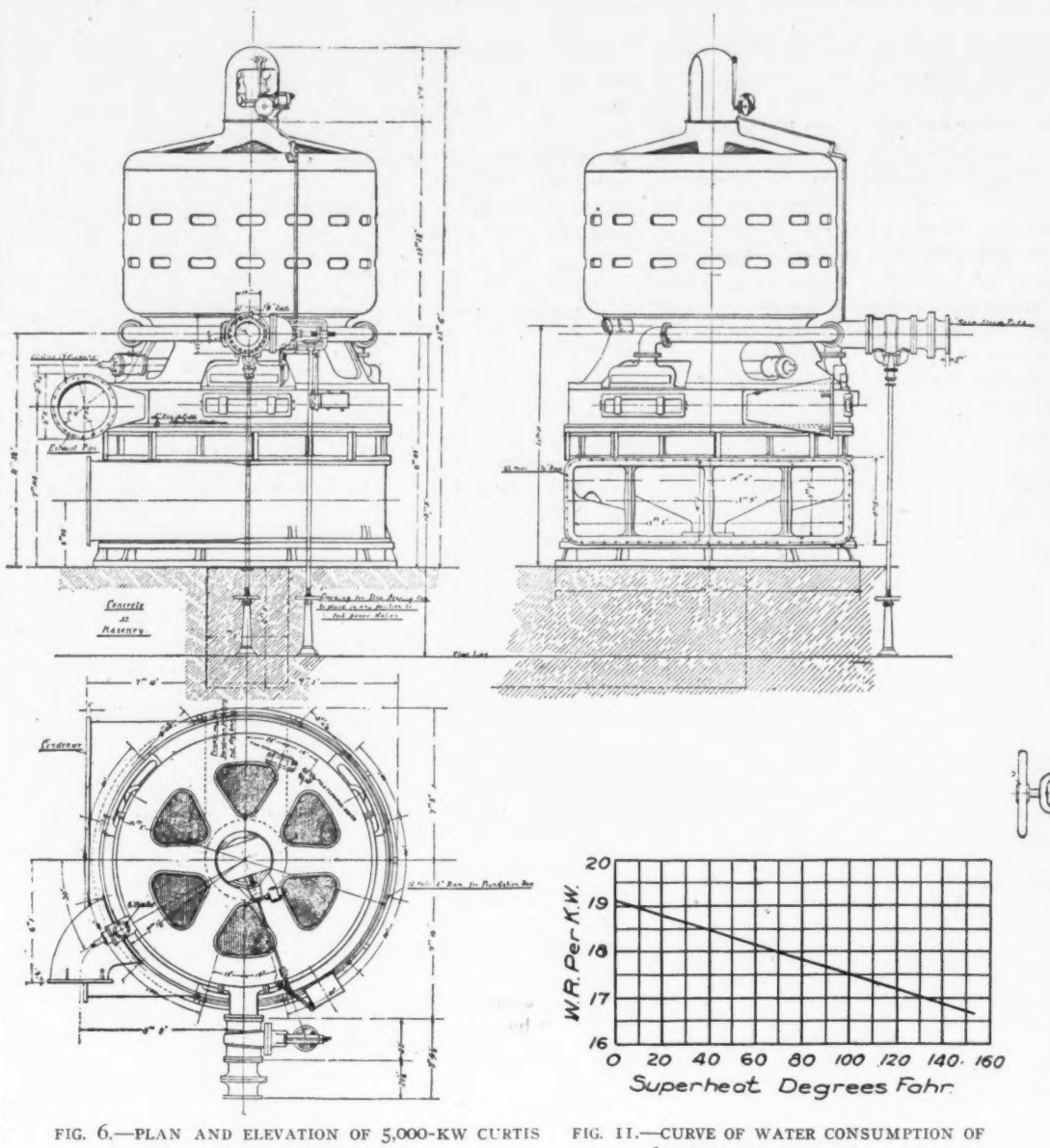


FIG. 6.—PLAN AND ELEVATION OF 5,000-KW CURTIS TURBINE WITH GENERATOR.

FIG. 11.—CURVE OF WATER CONSUMPTION OF 600-KW CURTIS TURBINE.

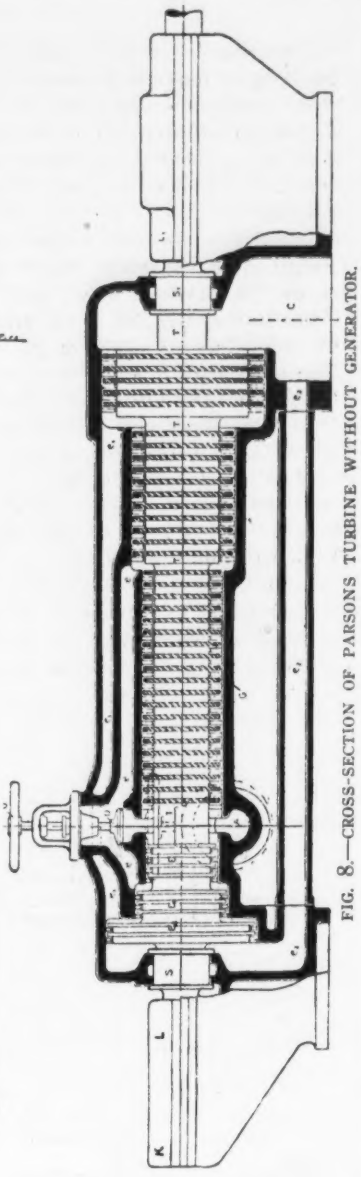


FIG. 8.—CROSS-SECTION OF PARSONS TURBINE WITHOUT GENERATOR.

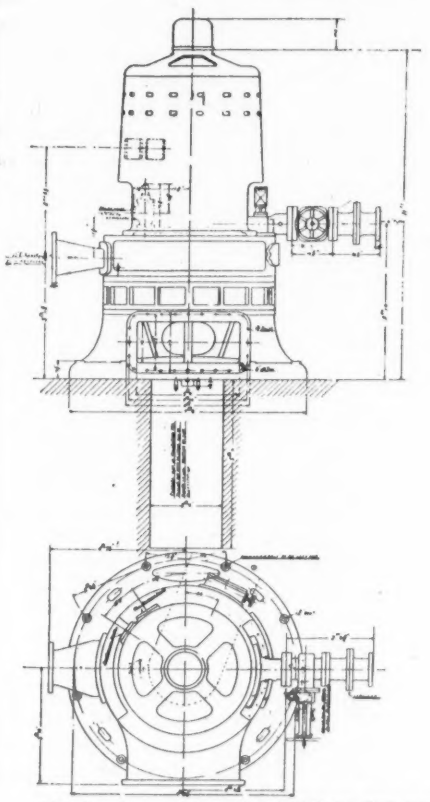
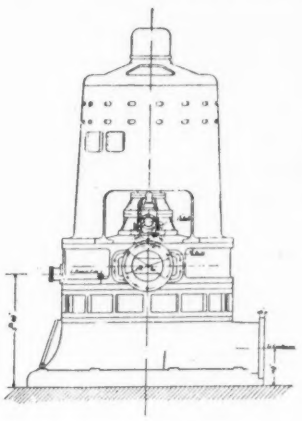


FIG. 7.—PLAN AND ELEVATION OF 500-KW CURTIS TURBINE WITH GENERATOR.



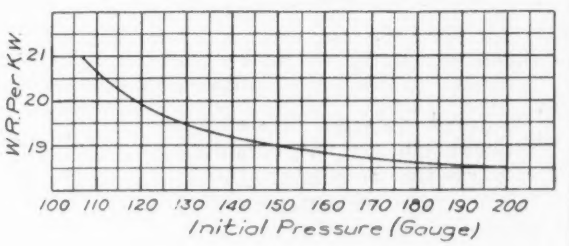


FIG. 10.—CURVE OF WATER CONSUMPTION OF 600-KW CURTIS TURBINE.

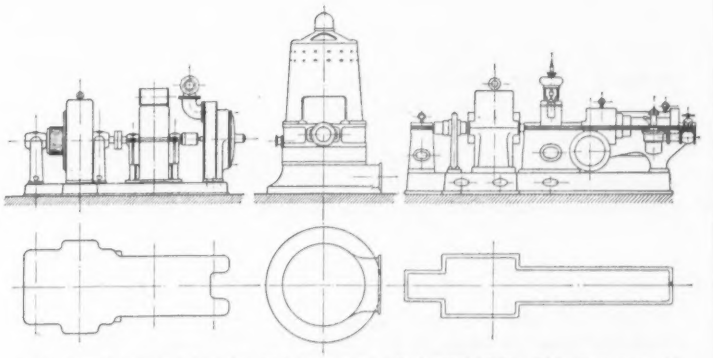


FIG. 9.—COMPARISON OF 200-KW DE LAVAL TURBINE, 500-KW CURTIS TURBINE AND 375-KW PARSONS TURBINE.

better than those obtainable from the types of steam engines generally applied to the production of electricity.

It should be noted that these curves show a very high efficiency at light loads, as compared with results obtainable from steam engines, and that the efficiency does not fall off at overload as it must necessarily do with all engines which operate economically under normal full-load conditions. This light-load and overload economy is an important feature of the Curtis turbine, and arises from the fact that the functioning of its working parts is virtually the same under all conditions of load.

Figs. 10, 11 and 12 show the effect upon steam consumption of changes in the steam pressure, the degrees of superheat and in the vacuum. It will be observed that the superheat and vacuum curves are straight lines so inclined as to indicate a great advantage by the use of all degrees of superheat and also an immense advantage in the use of very high vacuum. The most important reason why the Curtis turbine so greatly surpasses the steam engine in economy is that it is adapted to use effectively the highest possible degrees of expansion, while in the steam engine it is practically impossible to provide for high degrees of expansion. As the exhaust pressure approaches a perfect vacuum, the volume naturally increases at a rapid rate—the volume of steam with a 29-in. vacuum being double that with a 28-in. vacuum. To handle high degrees of expansion, it would, therefore, be necessary to make cylinders of steam engines

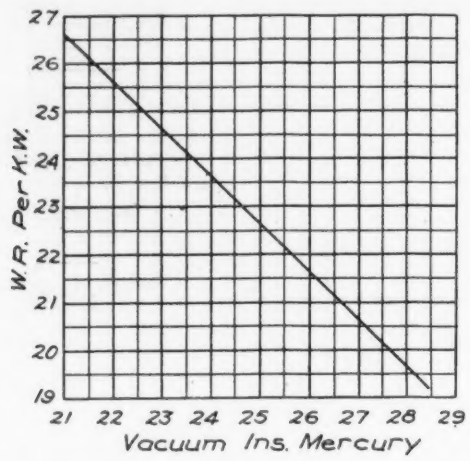


FIG. 12.—CURVE OF WATER CONSUMPTION OF 600-KW CURTIS TURBINE.

very large, and this increase of size and weight of parts fixes a practical limit which cannot be passed without excessive cost and complication. In the turbine, the highest degrees of steam expansion are easily provided for, and consequently a much larger proportion of the total work in steam can be utilized by turbines than by steam engines.

There are other conditions in the Curtis turbine which make high degrees of vacuum more easily attainable than they are under ordinary conditions. The machine is so constructed that leakage of air into the vacuum chamber is easily rendered impossible. The leakage of air into condensing engines is considerable, and is generally not checked owing to the small value of improved vacuum to an engine.

With turbines of the type here described, no oil comes into contact with the steam, and, consequently, condensed water can be taken from surface condensers and returned to boilers. The use of surface condensers under such conditions renders unnecessary the introduction of air either in feed or circulating water, and consequently makes possible a very high vacuum with small air-pumping apparatus.

The results shown by these curves are obtained from a machine of 600-kw capacity, and are naturally inferior to results which are expected from the very large units which are now being built. It is hoped that very soon after the reading of this paper a 5,000-kw unit, which is now complete, will be put into operation in Chicago. This machine is expected to give considerably better steam economies than are shown by the accompanying curves, and will be superior particularly in the matter of light-load performance. The variation of efficiency in this machine from half load to 50 per cent. overload, will not exceed 3 per cent.

The external appearance and dimensions of this 5,000-kw unit are shown by one of the drawings which accompany this paper, and another drawing shows this unit compared with an engine-driven generating unit of similar capacity. Each unit is shown as complete with prime mover and generator, one being the machine for Chicago, above mentioned; the other, one of the units which are operating in the Manhattan Railway Company's power station at New York. The comparison sufficiently illustrates the improvement which the turbine has introduced. The respective weights of these complete units, exclusive of foundation, are in the ratio of 1:8, and the saving in foundations alone is a very important item. Other drawings which accompany this paper show a 500-kw unit recently installed at Newport, and also a comparison drawn to the same scale between this 500-kw unit and a cross-compound engine unit of equal capacity designed to operate at 100 r.p.m. The contrast here is even more striking.

If the extreme simplicity of the Curtis turbine is considered in combination with these figures and comparisons, it is easy to appreciate that a very great engineering advance has been accomplished. It has been conservatively estimated that engine units, like those in the Manhattan Company's station, can be replaced by turbines like that in Chicago, and that the cost of such replacement can be paid for by saving in operating expenses in three years.

Whenever an improvement has been effected in prime movers, the influence upon engineering and business conditions has been very marked. When the release cut-off principle was introduced by Corliss, a certain improvement in engine economy was effected, and although this improvement was accompanied by no diminution in cost, the change resulted in a very great activity in engine building, and the renewal of most of the large mill engines in the country. It is, therefore, safe to predict that the influence of the steam turbine will be of radical importance. The steam turbine is, on account of its high speed, particularly adapted to the driving of electric generators, and its introduction will consequently stimulate the use of electricity rather than other power transmitters.

In the past the most economical use of steam has been confined to the most expensive and elaborate plants, while in the future it will be within the reach of all where condensing water is available.

Paris Gas Interests.

It was announced some time ago in the daily newspapers that possibly Mr. A. N. Brady and others might take an interest in the Paris gas plants. A cable dispatch from Paris of April 4 says: "The project of American capitalists to purchase the Paris gas franchise has played a considerable part in a bitter political controversy before the Municipal Council, aroused by the question of extending the franchise. Several newspapers have asserted that one of the leading companies seeking the franchise is American, and the *Matin* said Rockefeller interests controlled four-fifths of its capital. This brought out a sharp letter of denial, which the *Matin* published yesterday, from several leading French capitalists interested in the company. After referring to the report that the Rockefellers control the concern, the letter says: "Our project is not American, but is French. Its organization will be French and its administration exclusively French. The letter further denies the report that some of the religious orders own part of the company's stock."

Yarrow on Submarine Craft.

Mr. Yarrow, head of the shipbuilding firm, before the British Institute of Naval Architects last week came out strongly against the recent naval policy of France, Great Britain and the United States in building submarines. He said that he has no belief whatever in the submarine boat, either for offensive or for defensive purposes. He does not consider that anything practical will ever result from the experiments which all maritime nations are making in this direction. Submarines, if entirely successful or otherwise, would be of use only against stationary vessels. For the purpose of attacking vessels in motion they could not be guided, he maintains, with sufficient accuracy and knowledge to be relied upon, while even if they could, at least as much has been accomplished already by torpedo boats, with far less risk and cost.

De Forest Wireless Telegraph System.

BY A. FREDERICK COLLINS.

FOR some time much effort has been directed toward producing a receiving apparatus which would eliminate the coherer and provide in turn a swifter, surer means for indicating electromagnetic waves. The coherer, as is well known, retards the flow of a local current until the filings are drawn into closer proximity with each other by the action of electric oscillations set up in the resonator circuit by the received electric waves when the resistance is lowered from thousands to tens of ohms and permitting the local current to flow through the circuit.

In the ordinary silver filings coherer the resistance remains at its minimum value long after the last oscillation of the current, and in order to restore the local circuit to its normally high resistance it is necessary to decohere the filings either by electro-mechanical or purely mechanical means. A coherer of this type actuating a relay and a Morse printing register requires a definite period of time between the instant the first train of waves are impressed upon the resonator system of which it is a part and the reception of the second train of waves. This is due largely to the lag occasioned by the restoration of the filings to their normal state by mechanical means and the high time constant of the relay.

Another untoward effect produced by the ordinary coherer is due to the dual circuits required to operate a Morse register, and a fourth difficulty is caused by the sparks which occur between the filings, which process sets up oscillations emitting miniature trains of electric waves, and unless exceeding care is exercised will be registered as a Morse character on the tape.

Dr. Lee De Forest has invented, in conjunction with Mr. E. H. Smythe, a responding device for receiving, transmitting and indicating electromagnetic waves, in which the electric oscillation builds up resistance in the responder, as the De Forest-Smythe wave detector is termed, instead of decreasing it as in the filings coherer, and yet the responder is not an anti-coherer, but is based fundamentally upon the laws governing electrolysis as produced by high-frequency currents. The resistance of the circuit, including the responder and the means of indication, is uniformly increased and is proportionate to the energy of the received electric waves, the resistance being decreased again by the action of a local circuit. The action and reaction of the responder, according to investiga-

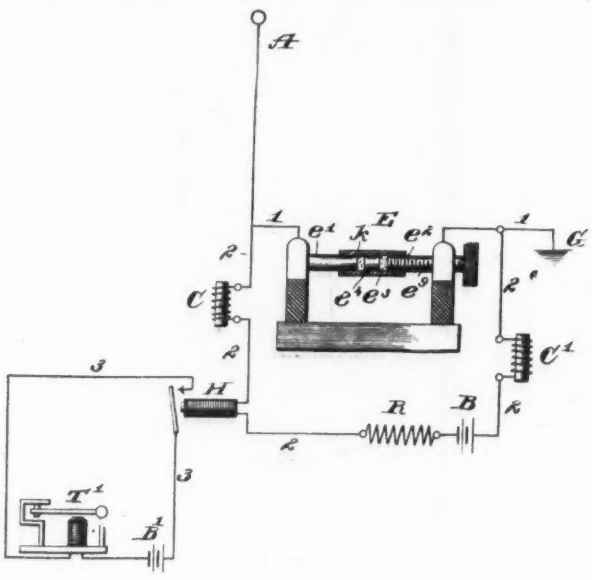


FIG. 1.—DIAGRAM OF DE FOREST-SMYTHE RESPONDER.

tions of the inventors, is that the responsive device normally maintains a number of conducting paths, and these paths are interrupted by the oscillations set up by the received electric waves in the resonator system, which increases the resistance of the responder; but when the high-frequency currents cease the local direct current reconnects the conducting paths instantaneously and the normally low resistance is re-established.

By this method it is claimed that an instantaneous and automatic return is secured of the normal conditions of the detector after each series of oscillations are indicated and without any auxiliary apparatus for tapping back, thereby providing a detector of exceptional rapidity, certainty of action and suitability for long-distance work—in short, fulfilling to a nicety the most rigid requirements imposed upon a detector in actual work.

The De Forest-Smythe responder is shown diagrammatically in Fig. 1, and is connected with the resonator system and local circuit exactly as is a coherer or other wave-detecting device. *A* represents the aerial receiving conductor or antennæ, *G* the earthed terminal or grounded wire, and *E* the responder; the responder comprises electrodes or conductor plugs, e^1, e^2, forced in a glass or other insulating tube, *K*; the space or pocket, e^3, is filled with a special compound or medium which will be fully described below.

The local battery, *B*, provides current for actuating an indicator of any suitable type, but in actual practice takes the form of a telephone receiver; the local circuit includes the responder, a battery and choke coils, *C*, *C*¹, in oppositely disposed arms of the circuit as shown, and a resistance, *R*, usually made variable to provide a current suitable for the varying resistance of the responder.

The action of this responder is essentially of an electrolytic nature, for it was discovered by the inventors that when two metallic elec-

FIGS. 2 AND 3.—DE FOREST-SMYTHE RESPONDER, BEFORE AND AFTER DISRUPTION.

trodes are slightly separated and included in series with a source of current and a suitable medium is interposed between their opposed surfaces, minute metallic particles are detached from the anode and thence carried across the gap separating the electrodes to the cathode, where they build up bridges which extend toward and soon reach the anode, thus bridging the gap. In Fig. 2 is shown schematically the metallic thread deposited by electrolysis of local current; and in Fig. 3 the disruption of the thread on the passage of an oscillating current.

It is evident that as long as electrolysis takes place the connecting metallic thread or bridge continues between the electrodes of the responder, which opens a practically free passage for the current derived from a cell; but the effect of high-frequency oscillations such as are set up by impinging electric waves is to instantly disrupt or break down the metallic threads formed by the local current when the resistance is increased by several thousand ohms.

The process involved in making and breaking these conducting threads is accomplished practically instantaneous, and if the responder is connected with a telephone receiver the increasing and decreasing resistance of the circuit is manifested audibly.

Originally water was employed in the gap between the electrodes, which was sufficiently sensitive to indicate the electric oscillations, but it was neither accurate nor permanent. By means of the microscope it was ascertained that when water was used between the electrodes of the detector a direct current from a battery deposits particles of metal from the anode and deposits them on the cathode; and if the process is continued for some time, the particles continue to be deposited until a minute thread is formed connecting the electrodes, as shown schematically in Fig. 2, and when this takes place feeble electric oscillations such as are produced by the received electric waves are unable to disrupt the metallic thread and the detector is said to be "clogged."

To eliminate this undesirable effect and to increase and maintain the sensitiveness of the detector, a great number of different substances was interposed between the electrodes and exhaustive tests conducted in order to ascertain a suitable medium. Viscous liquids, including glycerine and heavy oils, viscous semi-solids, such as vaseline powders, sulphur, oxides of lead and mixtures of PhO with glycerine and collodion and gelatine were employed, as well as manganese dioxide and potassium chlorate. It was found that when these media were used they limited the number of threads or bridges built up by the local current and concentrated the action of the electric oscillations to and upon these threads. The effect of the oscillating current on the deposited metallic threads segregates and precipitates it quite gently instead of violently disrupting it, such an action being represented in Fig. 3; when instantly this operation of the oscillations cease the process of building up takes place.

The microscopical analysis made showed that when the oscillatory

current is superimposed upon the local direct current, minute bubbles of gas are liberated at the cathode and along the deposited particles forming the deposited metallic thread; the investigations also showed that the segregation of the particles forming the thread is directly due to this sudden generation of gas, and that the action is "largely one of disruptive electrolysis in a film of electrolytic liquid interposed between each metallic particle and its neighbor."

To fulfill the theory thus evolved it is necessary to introduce

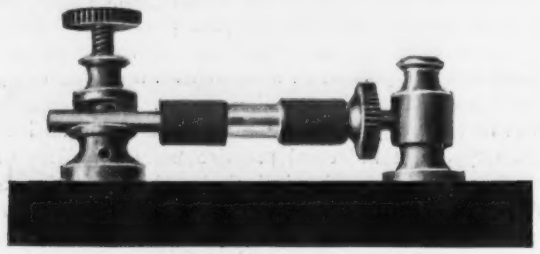


FIG. 4.—GENERAL VIEW OF RESPONDER.

some suitable electrically decomposable medium, such as water with the supporting medium in which the particles forming the thread are suspended. In practice commercial glycerine is used and fulfills the above requirements nicely, since water exists in commercial glycerine as an impurity.

The investigation also indicates that the gas liberated is hydrogen, and the oxygen set free effects a combination with the metal of the anode, or in the case where glycerine is employed as the sus-

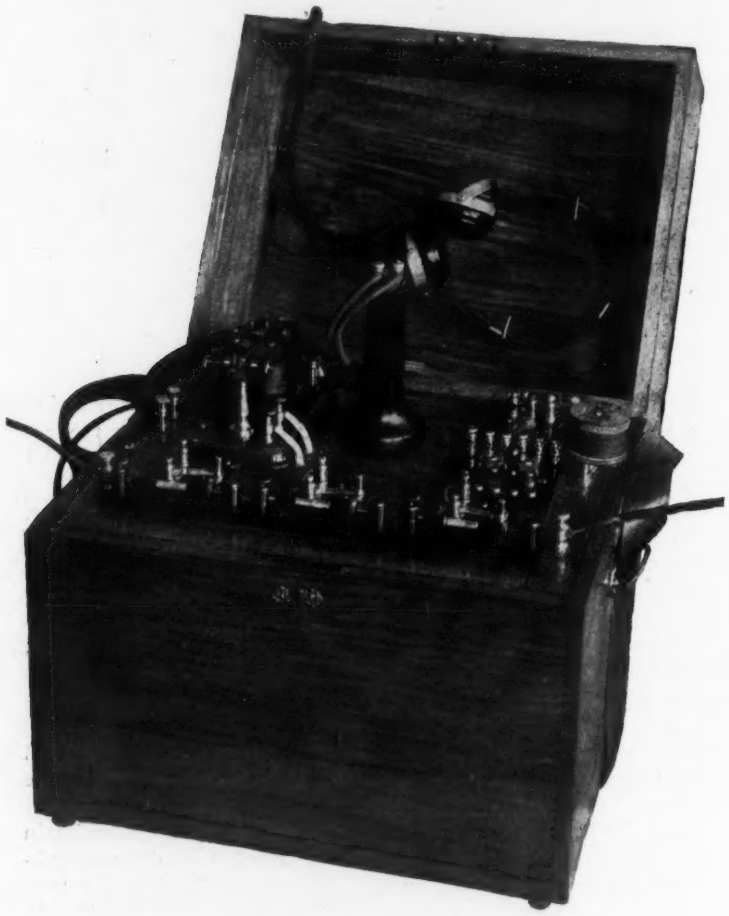


FIG. 6.—GENERAL VIEW OF RECEIVER.

taining medium, "the chemical activity of the nascent oxygen may be sufficient to cause it to abstract hydrogen from the glycerine to form water."

The inventors in their patent state they have obtained the best results with the oxides of lead and that these substances act as a depolarizer as well as a sustaining medium. The gas arising from the electrolytic processes referred to above may be absorbed by substances such as finely divided sulphur, which are interposed between the electrodes.

The terminal conductor plugs or electrodes employed in the responder are about an eighth of an inch in diameter and separated one-sixteenth of an inch. The oppositely disposed surfaces may be either smooth or roughened. A screw adjustment is provided for determining accurately the sensibility of the responder.

The complete detector is shown in Fig. 1, and consists of an insulating tube, *K*, of glass or ebonite, an auxiliary electrode, e^4, being forced between the electrodes, e^1, e^2 proper. In the spaces or pockets is the sensitive medium, composed of rather coarse filings and oxide

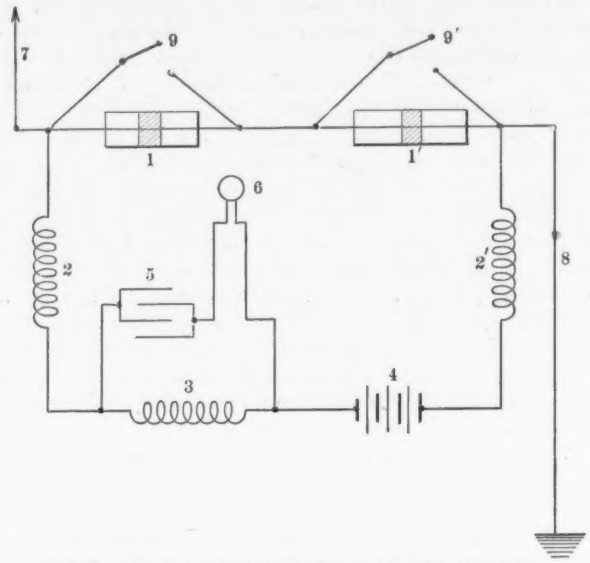


FIG. 5.—DIAGRAM OF WIRELESS TELEGRAPH RECEIVER.

of lead in equal proportions by bulk and made into a paste by the addition of glycerine or vaseline with a trace of water or alcohol. The local circuit should have a small value, preferably one-tenth to one milli-ampere, or when two cells are inserted in the circuit a resistance of 12,000 to 15,000 ohms is necessary to obtain the proper relative values. A photographic reproduction of the responder is given in Fig. 4.

In practice two electric wave responders are usually connected in series as shown in Fig. 5, and included in the circuit are two choke coils, 2, 2', a resistance of 5,000 ohms, 3, and a three-cell battery, 4; with tre resistance in circuit is a condenser, 5, and a head telephone, 6. The complete receiver is illustrated in Fig. 6. The transmitter

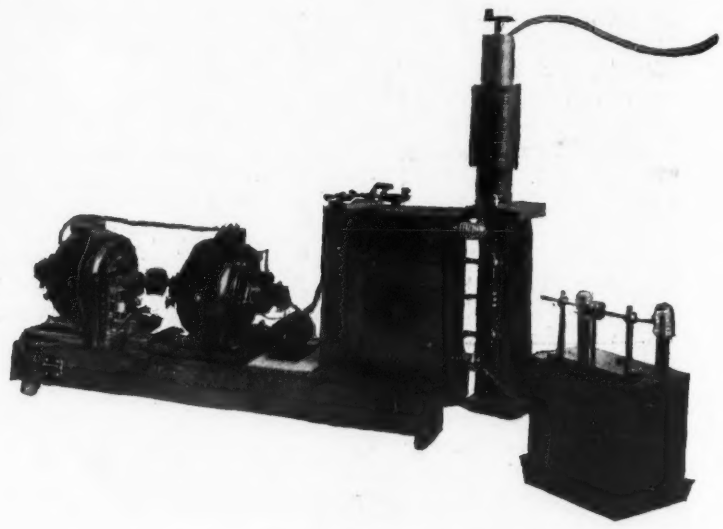


FIG. 7.—GENERAL VIEW OF TRANSMITTER.

employed in this system is shown in Fig. 7; it consists of an alternating-current generator, which energizes the primary coil of an oil transformer with a 500-volt current which is stepped up to 20,000 volts in the secondary coil; this in turn charges a battery of Leyden jar condensers to its maximum capacity, when it discharges through an air-gap setting up oscillations of great intensity in the oscillator circuits. The generator is driven by a gasoline engine except where a current is otherwise available, when a motor is connected direct to the alternator, the former operating on a 110 or 220-volt direct-current circuit.

Quick Work After the Helena Fire.

Last October the power plant of the Helena Light & Traction Company, of Helena, Mont., was almost entirely destroyed by fire. Through the courtesy of Superintendent R. A. Wilson, some particulars are here given as to the remarkably quick work which Mr. Wilson and his staff performed in getting the plant into service again.

At this station steam power was abandoned several years ago, and the company has been getting all of its power over an 11,000-volt transmission line from the plant of the Missouri River Power Company at Canon Ferry, 18 miles distant, on the Missouri River. The Helena Light & Traction Company supplies practically all the electric lighting and power work in the City of Helena, as well as the street railway service. The number of lights installed is about two per capita of population, which is an unusually high percentage for a city of the size of Helena. As the company supplies so much electric lighting, and practically all the power in the city, the interruption of the service was a great calamity to the community. At the time of the fire it was thought by many that it would be weeks before service could be resumed, as the station was apparently a total wreck. As a matter of fact, it was just fifty hours from the time of the fire that Superintendent Wilson began to give electric lighting service; and in a few hours more the street railway service was resumed.

The station which was burned was an old steam power plant which had been converted into a sub-station at the time that water power was first transmitted to the city. The fire started at a short circuit, where the 11,000-volt line entered the building. It is believed to have been caused by some tarpaulin which fell across the lines. The destruction of the plant was so rapid that the chief engineer, after telephoning the alarm, could not secure his coat, which was hanging near the switchboard, and which contained a large sum of money.

Fig. 1 shows the interior of the temporary transformer room, which is now doing service. Mr. Wilson does not consider the wiring as a standard of excellence, to be copied; but it served to give power and light to the people of Helena within fifty hours after the breakdown.

The exterior of the old station, the stone wall of which is still standing, and the temporary shed in the foreground, which is at present serving as a station, is shown in Fig. 2. In getting this temporary plant into operation, some feats were performed which are not down in the text-books on electrical construction. For example, some of the high-tension cable was manufactured by pulling wires out of the ruins and covering them with ordinary rubber hose. Some of these cables can be seen in the foreground in Fig. 1. Many of the switches were taken out of the ruins and made serviceable by the use of a file. In the fifty hours that elapsed between the burning of the building and the resumption of service, a temporary shed was erected, transformers were hauled 18 miles over the mountains from the water power plant at Canon Ferry, and all the wires strung. The service wires for the City of Helena stretched directly over the ruins, making a tangle which had to be straightened out, and adding considerably to the work of resuming service.

The "railway department" of the temporary plant is shown in Fig. 3. Induction motors which were taken from the ruins were belted to some direct-current dynamos secured in neighboring towns. It is a striking testimonial to the indestructibility of the induction motor that these motors were simply pulled out of the ruins, dried out and had their terminals and leads renewed before being put into service.

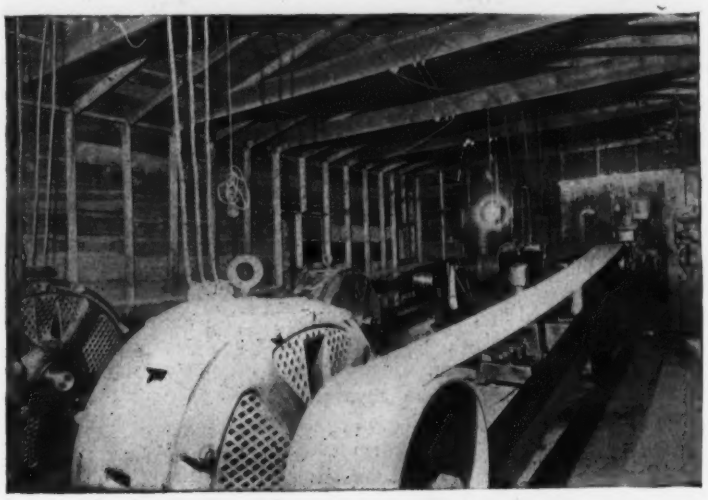


FIG. 3.—RAILWAY PLANT IN TEMPORARY STATION.

The fire was even more instructive as regards the performance of the oil-filled transformers. Some constant-current transformers which went through the fire were used immediately afterwards, after being dried out and having the oil renewed, and some small repairs made on such of the insulation as was reached by the heat. The oil protected most of the coils. Some of the larger high-tension transformers were located over a pit on the wooden floor, and the fire burned out the floor, tipping them over into this pit. Of course, the oil which was thus dumped into the pit made a tremendously hot fire. It was believed, however, that if all the transformers in the station had been on a solid foundation, with covers on tight, and with water-cooling system outside of the oil, they would have survived the fire without injury.

Plans have been prepared for a handsome sub-station to take the place of the one destroyed, which will be made one of the most completely equipped distributing stations to be found in the United States.

FIG. 1.—TEMPORARY TRANSFORMER ROOM.

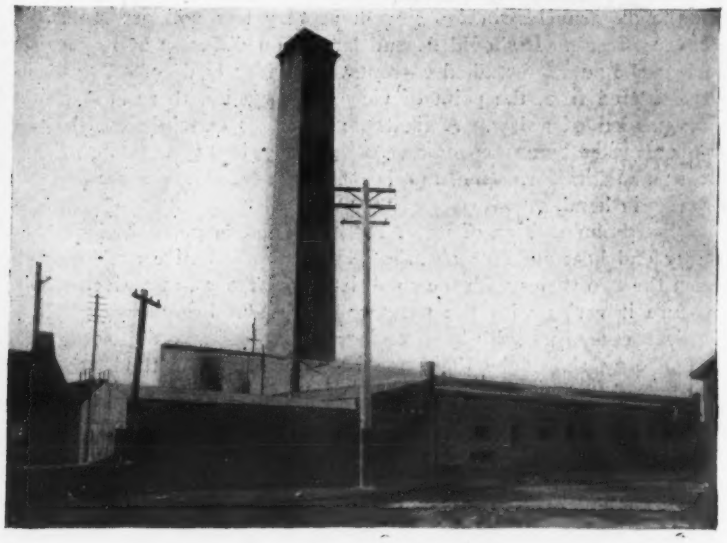


FIG. 2.—TEMPORARY STATION.

Electrolysis of Water.

IN an article in the March number of the *Journal of Physical Chemistry,* Prof. W. R. Whitney discusses the continual electrolysis of water at voltages below the so-called decomposition value, on the basis of the application of the Nernst formula for e.m.f. of polarization. Dr. Bigelow has repeated the early experiments of Helmholtz in which water, in closed vessels, is shown continually to conduct the current when the potential difference across the cell is only one volt. For visible decomposition, about 1.7 volt is necessary, and this is approximately the value calculated by the erroneous process of considering the heat of the chemical reaction to be exactly equal to the electrical energy obtained from the reaction when generating a current, or equal to the electrical energy necessary to bring about the decomposition of water into its component gaseous products at atmospheric pressure.

The recent advances in electrochemical knowledge lead to the conclusion that whenever an e.m.f. is applied to a pair of electrodes in an electrolyte, if its value is too small for visible electrolysis, there immediately occurs at least such an amount of real electrolysis as is capable of changing the poles into electrodes whose characteristic e.m.f. is equal and opposite to the impressed e.m.f. The earliest experiments on polarization point to this as a fact.

In the case, then, of an aqueous solution, the electrodes at one volt impressed e.m.f. are so charged with oxygen and hydrogen that they are to be considered as gas electrodes of low gas concentration or pressure. No reason appears for not accepting this conception as representing a condition to be expected. The gases could escape as bubbles only when the concentration had at least reached that value at which a gas pressure equal to that upon the liquid was reached, i. e., the atmospheric pressure. Helmholtz certainly recognized this principle when he drew the conclusion that with gas electrodes the e.m.f. should be different for each different pressure of the gas. This he then expressed in the form,

$$A - A_1 = C \log p/p_1.$$

If these electrodes represent the gases at low pressure these gases should certainly dissolve in the water and tend to reach a condition of saturation corresponding to the above concentration. In an open vessel this might never be attained, owing to the continual escape of the gases into the air, where their partial pressures are low. As it is well known also that these gases when dissolved in the electrolyte are capable of depolarizing the electrodes, especially the hydrogen and the oxygen electrode, a current at very low voltages seems a necessary result. It should depend largely on diffusion and convection, as the actually studied current very evidently does.

Considered from the point of view of energetics, there is also no transgression of a law. A molecule of water certainly could not be decomposed by an expenditure of less total energy than would be generated in its formation, nor is such an assumption necessary to the case in hand.

In the decomposition of water by the current in general, electrical energy and heat are both absorbed, but the quantitative relation between the two varies with the conditions. Moreover, at a given temperature it varies with the pressure so that at low pressures less elecrical energy should be necessary than at high, although the total energy should be the same in all cases. The total energy-difference between the water and its gases will be the same at a given temperature for all concentrations because of the constancy of the value of the product of pressure and volume for these gases, but the difference in free energy will depend upon the perssure and volume of the gases, for the greater the volume the less the free energy they contain. The electrical energy obtainable from these gases under ideal conditions is a measure of the free energy they contain. At great attenuations this would become very small, though the heat of reaction would be the same as before; conversely the decomposition of water into these attenuated gases requires the application of but little work.

The quantity factor of the electrical energy necessary to decompose the water is the constant of Faraday's law, but the intensity factor by which this must be multiplied to give the energy necessary, is the e.m.f. of polarization. This, in accord with the Helmholtz-Nernst conceptions, is a function of the concentration of the active electrodes. This has been shown to be the case with cadmium and zinc amalgams, and it is natural to assume that it applies to the case of gas electrodes.

Dr. Bigelow's experiments really support this view. For example, the minimum current reached in his various cells when corrected for size and resistance of electrolyte is practically a constant whatever precautions were taken to previously remove gases from the electrolyte. In fact in the single case where he could have observed the actual production of gas at low pressure above the electrolyte he apparently did so, but attributed it to a leakage of air. It seems most probable that a low rate of electrolysis existed in each of the several experiments described. that this started without the introduction of dissolved gases and probably reached a condition of equilibrium in which the diffusion of one dissolved gas to the other electrode in both cases caused continual depolarization. In such a case there should also have been some gas pressure above the electrolyte and this while not demonstrated, was really indicated by the experiments.

It would seem a radical step to adopt the theory of Dr. Bigelow that simple dissolved gases conduct the current and the facts hardly warrant it. To build upon this theory the additional theoretical structure involving the mysterious corpuscles of Thomson would be still more dangerous. If all the phenomena of this particular subject seem on careful investigation to be in accord with our present theories it is simply fortunate.

Accurate Measurements of Heavy Currents.

BY P. LETHEULE.

THE Laboratoire Central d'Electricité has been carrying out experiments on accurate measurements of very high and very low intensity currents, the results of which are embodied in a paper read at the February meeting of the Société Internationale d'Electriciens by Prof. Janet. These experiments, which were performed under his supervision by M. Iliovici, refer to alternating currents of more than 1,000 amp, the measurement of which is rendered difficult by the awkward nature and large size of the conductors.

The methods in general use for accurately measuring high intensity currents are the shunt method and the Kelvin kiloampere balance method. This latter shows a systematic difference which exceeds 2 to 3/1000 amp in continuous current, and 4 to 5/1000 in alternating current when the frequency varies from 25 to 60 cycles, probably due to Foucault currents in the conductors of the Kelvin balance.

The transformer method was shown to be equal in accuracy to the preceding ones, though not limited, as are the latter, by the intensity of the currents measured. Certain conditions, nevertheless, have to be conformed to, which will be dealt with later.

The transformer consists of an iron ring provided with two windings, the respective numbers of turns being n_1, n_2. With corresponding currents, I_1, I_2, and when no self-induction takes place between the two windings, we have the simple equation, $n_1I_1 + n_2I_2 = O$.

In practice, however, the primary and secondary circuits do not conform to the ideal conditions, the secondary being in part composed of an ammeter, the primary winding of which is far from uniform by reason of the large section and bulky nature of the conductors. Magnetic leakage, therefore, takes place between the windings. The magnetic permeability also varies, and other disturbing influences are due to Foucault currents and hysteresis loss in the core of the ring.

For the sake of analysis, M. Janet at first neglects hysteresis and Foucault currents. The leakage taking place between the windings is accounted for by adding to the effect of uniform winding, the effects of additional inductance, l, in the primary circuit and inductance and resistance, l_2r_2 in the secondary circuit (containing the ammeter).

Now, considering the hysteresis and Foucault currents, these can easily be derived from the respective losses in watts due thereto,

$$W_H = I_1' \times U_1$$
$$W_F = I_1'' \times U_1 \qquad (U_1 \text{ being the primary e.m.f.}),$$

and added geometrically to the primary current, I_1, determined at first, $I_1 = (I_1 + I_1' + I_1'')$. I_1' and I_1'' being almost completely energetic, the arithmetical addition of the terms will be sufficient

in practice and will give a value slightly superior to the current to be measured.

From the reasoning above outlined, we find that the ratio, $\frac{n_1 I_1}{n_2 I_2} = y$ departs from unity, and accurate calculation of its value has given the formula:

$$y = \sqrt{1 + \frac{R^2}{16\,\pi^2\,w^2\,n_2^2}\left(\frac{r_2}{n_2}\right)^2} \qquad (1)$$

This result, which is remarkable in that the value of y is independent of r_1 and l_1, and only varies with the reluctance, R, the frequency, w, the number of secondary turns, n_2, resistance of winding, r_2, including the reading ammeter ($r_2 = r'_2 + r''_2$).

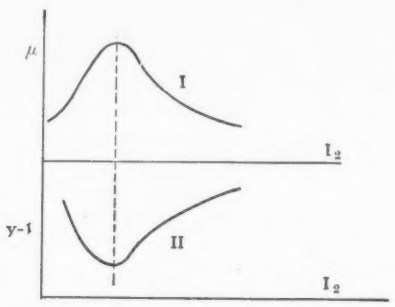
Fixing the frequency, w, it is interesting to note how y varies with I, which can be determined by means of the formula (1) and the following formula (2):

$$\phi_{max} = \frac{r_2\,I_2\,\sqrt{2}}{n_2\,W} \qquad (2)$$

y is related to reluctance R or inversely to permeability, μ by the formula (1). μ is related to ϕ by the curve of permeability (upper curve I of the accompanying figure).

Both formula and curve, I, therefore, permit the elimination of R and ϕ, or μ and ϕ, and to draw the curve relating y to I_2, or $y - 1$ to I_2, curve I I.

and 100 $(y - 1)$ as ordinates, show the influence of a change in frequency; decreasing $y - 1$, it results from above formulas and experiments that r_2 should be made as small as possible. Experi-



MEASUREMENTS OF HEAVY CURRENTS.

ments with different ammeters have shown that greater accuracy is obtained with the least resistance in ammeter circuit.

Now investigating the hysteresis current, I', Mr. Iliovici found that it was no longer dependent upon the primary constants of the main current, I, under the following conditions:

Connecting n_1 primary turns all in series or in multiple changes, I_1, proportionally as seen from formula (1); it also changes I_1' in the same ratio, as proved by experiment and calculation.

Calculation, in fact, gives for I_1':

$$I' = \frac{W}{U_1} \qquad (3)$$

$$U_1^2 = \frac{A r_1^2 + B\,l_1^2 + C n_1^2 l_1 + D n_1^2 r_1 + E n_1^4}{F n_1^2} \qquad (4)$$

A, B, C, D, E, F being functions of I_2.

The formula (4) shows that putting in series n_1 turns first connected in multiple is equivalent to multiplying the numerator by n_1^4; the denominator by n_1^2 and the result by n_1^2; U is multiplied by n_1 and I is divided by n_1.

The geometric sum, $I_1 + I_1' + I_1''$, is, therefore, modified in the same proportions as the separate turns; that is, all divided by n_1, and resultant ampere-turns $n_1\,(I_1 + I_1' + I_1'') =$ constant.

Experiments made before the Institute by Mr. Janet prove the constancy of the resultant ampere-turns.

The ring used was made of 39 iron sheets, 0.066 cm in thickness. The external diameter was $D_1 = 15$ cm, and the internal diameter of ring $D_2 = 13$ cm. There were 250 secondary turns and 15 primary turns.

The same readings are made when the primary turns are all connected in multiple and carry 750 amp, or all in series (15) with 50 amp. Practical use can be made of such rings with one primary turn carrying as many amperes as needed. The accuracy, varying from 1 to 4/1000 in the most unfavorable cases, is fully equal to the requirements of the standardizing laboratories.

The Construction of Aerial Telephone Lines—IX.

By Arthur V. Abbott, C. E.

JOINT USE OF LINES BY TELEPHONE AND ELECTRIC LIGHT COMPANIES.

IT often happens that telephone and light companies must carry their circuits along the same highways, and in many cases streets are so occupied as to compel the joint use of poles by both companies, for frequently municipal authorities enforce such a partnership. Both companies, naturally, have grave objections to allow any other circuits upon their poles, and probably wisely use every means to delay and retard such joint occupancy as long as practical. That there are some vital objections cannot be gainsaid; but with proper precautions and restrictions, it is untrue to say that such occupancy is not feasible.

There are two objections that the telephone company may argue to such joint pole line construction. If the wires of the electric light company are placed above those of the telephone circuits, a broken light wire may fall upon the telephone circuits and do much injury by burning off the existing circuits, or injuring apparatus at the sub-stations and in the central office, and by frightening or even killing the employees of the telephone company or possibly its subscribers.

If the wires of the electric light company are placed below those of the telephone company, the linemen employed by the telephone company must crawl through the lighting circuits whenever any pole is visited, and, consequently, are exposed to extreme hazard shock. From the lighting company's standpoint, two objections also exist. If the telephone wires are below the lighting circuits, electric light linemen must crawl through the telephone wires. This is a performance which is not attended with any danger, as far as shocks from the telephone plant are concerned, but the presence of the telephone wires certainly retards work of the linemen and causes it to be more expensive. If the electric light wires are placed below the telephone circuits, a broken telephone wire may drop upon the electric light circuits, and injure the lighting company by opening its circuit-breakers, and otherwise putting its circuits out of commission. All of these objections are real and valid, and should be given due weight when an endeavor is made to enforce the use of joint lines. But when all is said and done it is possible for both companies to occupy a joint line; but, if compelled to do so by municipal authorities, companies should be exempted from suits for damages due to the presence of each other's wires, so long as both companies protect their circuits in the best-known manner. Where joint lines are used, it is usually customary to place the electric light wires above the telephone circuits, and allow a space of not less than six feet between the lowest electric light cross arm and the highest of the telephone circuits. A notable and good example of this form of construction may be seen on Euclid Avenue in Cleveland, where the lines of both the electric light and telephone companies occupy one side of the street, set upon 55 and 60-foot pole lines for some miles.

WIRE.

The best conducting material for open wire lines has always been a point of discussion. Early telephone circuits were invariably made of iron, but its rapid rusting, its objectionable resistance and more objectionable magnetic qualities have caused it to be discarded by all excepting those who are doing an inferior class of work. Extended experience points to the use of .080 B. & S. copper for all lines under from ten to twenty miles, .104 copper for toll and long-distance lines of magnitude, while .165 copper has been used by the transcontinental systems. It is doubtful, however, whether such large wire would be employed in the future. Iron wire, doubtless, has a place in the construction of telephone line where business to be transacted is relatively of minor importance; where distances covered are small, and where the line load is light, it is necessary to use the most economical form of a construction. For local work, under such circumstances, the use of iron wire is presumably preferable, but much false impression exists as to the economy of iron wire. It is argued that, as iron wire costs 3½ cents per pound, and copper wire 15 cents, about four-fifths of the cost may be saved by the employment of iron wire, but this is obviously fallacious; for the cost of the line is not only that of the wire, but of the poles, cross arms, pins, braces, insulators and labor of erection, so that

the wire itself forms but a small fraction, or about two-fifths of the total cost of the line. If, therefore, a saving of four-fifths is made upon two-fifths of the cost, the actual saving is but eight twenty-fifths of the total cost of the pole line, and there are few instances where this economy is worth the decreased life and the poorer service rendered by the iron wire line.

There have been many attempts to construct some other form of wire, which would be preferable for telephonic purposes. A number of alloys, chiefly combinations of aluminum and copper in the aluminum bronzes, have been tried. These wires possess considerable greater strength than hard-drawn copper, but are always burdened with two or three times the resistance. For drop wires, alley lines, and other distributing purposes, wire of this description has a value, and its use in this direction is likely to increase, but it seems to be limited to such special locations. In times past many attempts have been made to form what is termed a bi-metallic wire or center of steel, surrounded by a coating of copper, upon the theory that the steel would contribute the necessary strength and the copper the desired conductivity. Theoretically all this is true, but practically the increased cost of manufacture does not enable such wires to show economy over regular hard-drawn copper, and from no other standpoint is their use desirable. Prior to the application of hard drawing to the manufacture of wire, the use of iron was almost a necessity, as ordinary annealed copper could not be made of sufficient strength to support itself over the proper spans under a snow load. But when Mr. Doolittle showed how greater tensile strength of copper could be increased by the process of passing it through a die, without subsequently annealing, the fate of iron wire was sealed, as the increased tensile strength thus secured to the copper made it capable of sustaining itself under all ordinary conditions of span and load. In using hard-drawn copper, however, it must not be forgotten that the value of the material lies in the surface skin, and that nothing should be done which in any way interferes with its integrity. Thus all tools or hard objects must be kept away from the surface of hard copper wire. It must under no circumstances be nicked or scratched, or bent at a sharp angle. Anything which disturbs its surface vitally injures its cohesive power. Any form of annealing will perform the same result, and, consequently, no soldering must be done upon hard-drawn wire, but all joints must be made with clamps—McIntire's, or by some other mechanical method.

Recent Electrochemical Developments.

BY CLINTON PAUL TOWNSEND.

EXTRACTION OF SUGAR.

The endosmotic method of Dr. Schwerin for extracting sugar solutions from comminuting beet roots or cane was described and illustrated in these columns, Vol. XXXVIII, page 942; and more recently (Vol. LXI, page 365) a modified apparatus for this and analogous purposes has been described. The current patent issue contains a further modification of the earlier process, this modification being applicable solely to the extraction of sugar. According to the earlier method the cane or beet chips to be extracted were packed between a cathode of wire-gauze and a diaphragm of filter-cloth, an anode being placed in water in a compartment beyond the diaphragm. This anode was of zinc or aluminum, these metals being capable of uniting with the acids of the normal juices to form insoluble compounds, thereby eliminating them.

In a construction of this kind the albuminoids which form a normal constituent of the juices are dissolved in the alkaline liquor at the cathode, and unless afterward removed by separate treatment will correspondingly reduce the purity of the sugar. This is said to be overcome in the present case by interposing between the cathode and the comminuted sugar-bearing material a layer of bone-black, preferably retained between filter-cloths. To facilitate retention of this layer a horizontal position of the apparatus is adopted. By interposing the bone-black in the path of solution moving toward the cathode the albuminoids are removed before they have an opportunity of dissolving in the cathode solution.

An independent improvement consists in substituting for the costly anodes of zinc and aluminum, plates of iron, and precipitating the organic acids by magnesium oxide, calcium carbonate, or other suitable compound held in suspension in the water of the anode compartment.

DENTAL MUFFLE.

These muffles as heretofore constructed have comprised a casing, generally of porcelain, in the inner walls of which platinum resistance wires were embedded, or in the latter models these wires have been bedded in separable plates with which the muffle walls are lined. The close bedding of the wires, as formerly practiced, has also been abandoned, on account of their liability to part under the expansion and contraction of the plates, and instead they have been merely passed through grooves or perforations of ample size.

A further step, in direct line with earlier progress, is represented in the furnace recently patented by Robert Winter, of Berlin. According to this construction the resistance wires are carried in tubes of porcelain which are loosely supported in horizontal grooves in opposite interior faces of the muffle, and evenly spaced by means of projections on their sides. The result is a further reduction in the size of the heating units, with correspondingly lessened liability to fracture under the necessarily violent temperature changes to which they are subject in use.

DEPOSITION OF GOLD.

Mr. E. D. Kendall, of New York, seeks to simplify the plating of gold by providing a solid composition which by mere solution in water will yield a suitable electrolyte; that is to say, the electrolyte from which gold will be deposited as the result of secondary action. The composition described is prepared by adding to a strong solution of trichloride of gold a slight excess of potassium hydroxide, followed by a considerable quantity of potassium ferrocyanide. The whole is then evaporated to dryness upon a water bath, grounds and preserved in air-tight packages.

Mr. Kendall also patents a composition designed for silvering brass, copper or other base metal by simple contact. This powder consists of silver chloride, one part; sodium thiosulphate, four parts, and a siliceous powder such as infusorial earth, four parts; and is applied directly to the carefully cleaned article to be silvered by means of a wet cloth.

Sylvanus Thompson on Gilbert.

The Royal Geographical Society has recently been making an exhibition in London of Elizabethan relics to signalize the tercentenary of the death of the great Queen. Among the objects exhibited there was very appropriately a unique collection illustrating the life and works of Dr. William Gilbert, one of Queen Elizabeth's Physicians-in-Ordinary, who has been called the "father of modern electrical science." This collection was formed by Prof. Sylvanus P. Thompson, who, as is well known, has made a special study of everything relating to Dr. Gilbert, and whose superb translation of the "De Magnete" was recently issued, a few copies being secured by fortunate subscribers on this side of the Atlantic at a price far below their present and future value.

In a speech at the Royal Geographical Society's meeting on March 23 in connection with the Elizabethan tercentenary, Prof. Thompson said of Dr. Gilbert: "By his magnificent generalization from the small-scale models to the globe itself, supported from point to point by experimental researches, he created the science of terrestrial magnetism. If from the imperfection of the data at his disposal he fell into sundry errors of detail, he yet founded the method of philosophizing by which those errors were in due time corrected. And if for nothing else than his masterly vindication of scientific methods, and his rescue of the subject of magnetism from the pedantry and charlatanry into which in the preceding ages it had lapsed, his memory must be held in high honor.

"To the names of the men who made great the age of Queen Elizabeth, who added lustre to the England over which she ruled, and made it famous in foreign discovery, in seacraft, in literature, in poetry, and in drama, must be joined that of the man who equally added lustre in science, Dr. William Gilbert. Alas! that of the personality of so great a man so little should be known."

National Electric Light Association.

Mr. C. O. Baker, Jr., master of transportation of the National Electric Light Association, states that the Central Passenger Association has granted a special rate of a fare and a third, on the certificate plan, from all points in its territory to Chicago and return, for delegates attending the twenty-sixth convention of the National Electric Light Association, to be held in Chicago May 26, 27, 28, 1903. A preliminary list of 125 questions has already been tabulated by Mr. Hartman, editor of the Question Box for the twenty-sixth convention, from questions already received from members. New questions are coming in daily, and this feature of the programme will contribute greatly to the interest and importance of the meeting. Many of the questions relate to subjects that have never before been brought up for discussion at the conventions, and they are sure to elicit valuable information.

CURRENT NEWS AND NOTES.

STUDYING EARTHQUAKES.—At the invitation of the German Government a conference with the object of founding an international seismic association will be held at Strasburg from July 24 to July 28.

WIRELESS TELEGRAPHY ON TRAINS.—The recent tests of wireless telegraphy between moving trains and stations on the military railway near Berlin, according to a despatch from that city, have been successful. It is stated that telegrams were exchanged without any difficulty. The Braun system is used.

WIRELESS PRESS NEWS is now a feature of the *London Times.* A wireless press association is, it is rumored, being quietly organized to embrace the United States and Canada. Thirty operators are to be stationed at the Glace Bay and South Wellsfleet stations of the Marconi system to receive and transmit messages. The organization is not yet completed, but is to be ready for service by the time that perfect communication is established both ways across the Atlantic. The service is also to be exchanged, it is said, with that of a similar organization in England.

A LONG KENTUCKY ROAD.—The Ohio Valley Traction Company has applied to the General Council at Louisville, Ky., for a right of way into the heart of the city. The company, which will be organized by ex-Congressman A. S. Berry, of Covington, is being backed by Eastern capitalists. The line will connect Cincinnati and Louisville, which are 110 miles apart, and two of the largest cities in the West. It will cost $3,000,000, and will have all the privileges of a trunk railroad line. It will open up a rich farming and mineral country. The construction of the road will be begun within the next few weeks.

GERMAN WIRELESS TELEGRAPHY.—It is stated from Berlin by special cable dispatch that the Allgemeine Electricitäts-Gesellschaft has received orders for twenty-five sets of Arco-Slaby wireless telegraph apparatus from the United States Navy Department. Another cable dispatch states that the German military authorities have successfully experimented with wireless telegraphy along the line of the military railroad between Berlin and Zossen, eighteen miles, for several weeks past, and continuous communication has been maintained between moving trains and the signal stations.

COLUMBIA'S NEW PROFESSORS.—The trustees of Columbia University have decided to fill the vacancy caused by the death of Prof. Ogden N. Rood by creating three new offices in physics. A new professorship in experimental physics is to be filled by the appointment of Prof. Ernest F. Nichols of Dartmouth College, and a new professor in mechanical physics by the appointment of Dr. Albert P. Wills of Bryn Mawr. The third new appointee will be Bergen Davis, tutor in physics, who is now studying under Prof. Thomson at Cambridge University as the Tyndall Fellow of Columbia.

A JOURNALISTIC "FREAK."—It is stated that German competitive enterprise is about to take another and original form. A journal devoted to electrical subjects is soon to be printed in Berlin in the English language, and circulated wherever the British flag flies, the object being to set forth the superiority of German electricians as compared with all comers. One of the curious features of the undertaking is that this new Anglo-German industrial publication is to be backed by one of the great German electrical manufacturing companies. An English technical journalist has been secured to edit the new paper.

BIG TRUNK TROLLEY SYSTEM.—It is understood that the Appleyard electric railway syndicate, which has been operating extensively in Southern Ohio, has planned an immense trunk line trolley system, giving a through line from Cincinnati to Cleveland by way of Columbus, and from Cincinnati to Toledo by way of Dayton and Springfield. This line, it is stated, when completed, will enter Cleveland by the way of Akron, and the Northern Ohio Traction Company will be part of the system. Some of the work still remains to be done between Cincinnati and Hamilton, but is now under construction. There is also a connection being made between Newark and Zanesville.

A MODERN LAKE STEAMER.—The steamer "City of South Haven," which was recently launched at Toledo, O., will be fitted out with a number of electrical features. She will be equipped with a complete telephone system, connecting each stateroom, and the exchange on board will be provided with a trunk line which will be connected with the local telephone systems at Chicago and South Haven when the steamer makes her landings there, thus enabling passengers to communicate with all parts of the cities without leaving their staterooms. The vessel, it is stated, will also be equipped with Marconi wireless telegraph apparatus and a daily newspaper will be published on board during the excursion season.

EGYPTIANIZED CLAY.—Mr. E. G. Acheson has recently been conducting some interesting work with clay earth, and has obtained a product called "Egyptianized Clay." This is obtained by a very simple treatment with tannins or similar extracts of vegetable matter whereby the clay is rendered very much higher in tensile strength, more dense, and the shrinkage is materialy reduced. To obtain this same effect was probably the real object of the use of straw by the Egyptians. This having occurred to Mr. Acheson, he extracted the soluble matters from the straw, throwing away the fibre, and by treating the clay with these soluble constituents obtained the above mentioned results. The tensile strength was increased as much as 350 per cent. in the sun-dried article.

BRITISH MUNICIPAL OWNERSHIP.—The government returns of the municipal plants operated in England, of all kinds, are not particularly encouraging. The average annual income for the 299 municipal undertakings amounted in the aggregate to rather more than $65,000,000, from which must be deducted $41,000,000 for working and other expenses. The apparent balance is about $24,000,000, from which again must be deducted nearly $15,000,000 for interest on money loaned, and nearly a million dollars for depreciation. If a further sum of $6,300,000 be subtracted for repayments of principal, there is a net profit of considerably less than $2,000,000. On further examination, this profit dwindles so seriously that it ought really to be a deficit. The amount invested in electrical current supply is $62,500,000.

STEEL CASTINGS IN IRELAND.—Mr. W. W. Touvelle, U. S. Consul at Belfast, Ireland, writes the State Department as follows: From recent investigations that I have made, and from numerous inquiries received from different firms in this city, I am satisfied that a good market is open to American manufacturers who can supply steel castings of high permeability for electrical works. Castings of magnetic steel, for field magnets of electric motors and dynamos, and magnetic steel or iron sheet stampings, of high permeability and low hysteresis, for armature cores, are mentioned. L. B. Mollan & Co., Alexander Street West, Falls Road, electrical and mechanical engineers and contractors, and Millin & Co., Ultonia Works, 59 Victoria Street, are desirous that their names may be brought to the attention of steel manufacturers of the United States, as they are large users of the castings described.

CHICAGO LIGHTING.—According to statements in the *New York Herald* as to prices paid by city employees in Chicago for the privilege of holding their jobs under the existing regime, linemen in the electrical department have to pay out $5; while lamp trimmers are also assessed $5. This goes into what is graphically called the "slush fund."

MASSENA PLANT.—A serious break occurred last week in the canal of the Massena plant. The bank which held the water of Froe Bay in check became undermined and gradually began to give way, causing an alarming leakage. A large number of men and teams, after working several days dumping tons of stone and other material into the opening, succeeded in stopping the leakage and danger is now considered past. It is stated that the damage will be heavy.

GERMAN ELECTRICAL COMBINATION.—A cable dispatch from Berlin of April 7 says: The arrangements for the combination of the Allgemeine Elektrizität and the Union Elektrizität Companies have been completed. Each concern will keep separate accounts, but will pool their profits, which will be apportioned according to the ratio of their respective capitals, the former company receiving fifteen-nineteenths and the latter four-nineteenths. The combination will become operative on July 1, and will continue for thirty-five years.

ALUMINUM-COPPER CONDUCTOR.—A patent issued March 24 to J. D. Nicholson describes a conductor having a copper core enclosed with aluminum. It is stated that a wire can be readily drawn from a compound ingot composed of the two metals, the core being of copper and the shell of aluminum. In coupling such wires the difficulty ordinarily found in soldering aluminum is not serious, as the copper part of the conductor can be readily soldered without raising the resistance of the joint. The claim is for a compound electrical conductor composed of a core and a shell of different materials drawn into wire, one metal being aluminum and the other copper.

OPERATING MOTORS IN DUST-LADEN ATMOSPHERES.—A patent granted March 31 to Thomas A. Edison describes means for operating electric motors in atmospheres which are heavily charged with dust, as in cement-grinding establishments, flour mills, etc. The invention consists in enclosing the entire motor in a casing consisting of a light framework covered with textile material, such as ordinary gunny cloth, the walls being double. Where the motor shaft passes through the casing a packed bearing is provided to exclude dust at that point. A fan is arranged within an opening in the casing to cause an outward draft from the same, a shield being so arranged at this opening as to prevent the inward flow of air around the fan, which would carry dust within the casing.

CHICAGO ELECTION.—Mr. Carter Harrison has been elected Mayor of Chicago for the fourth time, but by the smallest plurality in the series. The chief issue in the campaign was the traction question, both candidates favoring ultimate municipal ownership of the street railways. Mr. Graeme Stewart, the Republican candidate, advocated an immediate improvement of conditions, making the best terms possible with the companies. Mr. Harrison recommended a delay until the city had obtained what it desired from the companies after the election. Mayor Harrison said: "I regard the present election as less of a personal victory for myself than as a victory for municipal ownership and for the referendum—a victory which should lead to the development of public national as well as municipal utilities."

MASSACHUSETTS MUNICIPALISM.—The Massachusetts Gas & Electric Commission has recently made its annual report. During the fiscal year ended with June, 1902, the municipally owned electric plants of Massachusetts had a gross income from all sources of $157,390.35. Their gross operating expenses were $218,696.39. To this must be added interest on bonds, $39,395.55; depreciation, $55,729.29; losses, $447.36. The sum of these items, added to the net loss on operating account of $61,306.04, would indicate that the cost of municipal electric lighting over and above the charge made for it, was $155,032.34. Of sixty-three Massachusetts companies engaged in electric lighting, thirty-eight paid dividends and twenty-five did not.

INVENTORS AND THE NEW INDUSTRIAL SITUATION.—Mr. S. T. Dodd, the well-known electrical engineer, in a recent lecture on the development of the electric railway said that in gathering his notes on the subject the question has forced itself on his mind as to whether under modern conditions of business the same work would ever have been done, and whether if we had the same or a similar problem before us to-day, we would be able to solve it as the inventors of 20 years ago solved the street railway problem. Since that time business interests have been associated into the vast organizations of the so-called trusts, and, as a necessary concomitant, men have more and more associated themselves into labor unions. It is unquestionable that the natural effect of large organizations of either capital or labor is to reduce its members more and more to the level of machines and to specialize and narrow the work and efforts of each individual along certain lines while doing the work of the organization at the expense of the personality of the individual. He considers it absolutely certain that such men as Sidney Short, Thomas Edison and Leo Daft were not working for any thirty-million-dollar corporation. The query arises, if they had been, would they have been allowed to spend their time on the various apparently hair-brained ideas out of which has developed our electric railways? In particular, would they have exerted their efforts if they had known that their ideas were to be absorbed by the corporation and included under that general term of patents and good will, which disappears when the corporation is merged in a new organization? The labor unions of those days did not hold the position which they do to-day. The query arises, if they had would these men have been able to hire assistants who were machinists, carpenters, plumbers, painters and electricians combined. It is perfectly certain that these men were working for themselves and because they knew that the developments they made would be known by their names and would lay the foundations of their own possible fortunes. Mr. Dodd asks, Is such a condition of things possible to-day? Or, are modern conditions wiping out from among us the American inventor? If so, are they not also removing one of the most potent factors and incentives to advances in American mechanics, American engineering and American civilization?

LETTER TO THE EDITORS.

Stress on Frames of Alternating Current Generators.

To the Editors of Electrical World and Engineer:

SIRS:—I have read in your issue of February 14, 1903, the letter of Mr. A. Hansson, commenting on my article in the issue of January 24, 1903, having the above title. In this he says: "The author has neglected torque in the inner circumference of the core * * * the force due to this torque in the example given would be about 10,000 lbs."

It does not make any difference what the figures of this torque are, because it does not enter in the stress in the sections of the frame where the maximum stresses are to be found. It is the moment of this force we have to deal with, not the force itself. The bending moment of the said force for the two sections in a vertical plane through the shaft is zero. This is the reason why the force is neglected in the article, and it seems to be a pretty good reason.

The object of my article was to interest the designing electrical engineer in the stress problem. There is a wide field in America for this kind of work. Because material is cheap there in comparison with the cost of labor, saving in material has hitherto been a question of secondary importance. But while saving in labor, why not at the same time economize in material and consequently get the highest results? An article written with this object must not be too theoretical, because in the latter case it would probably not be read by the practical engineer, who is apt to prefer examples showing the application of theory. If any designer has received practical benefit from my article, I am very well satisfied.

The letter refers to an article in the *Elektrotechnische Zeitschrift* by Mr. Hans Linsenmann. This is a theoretical article relating to the deflection of frames, and as such is a very good one. Mr. Hansson does not appear, however, to have understood either this or my own article. They relate to subjects just as different as are the ideas of deflection and stress. Mr. Linsenmann in an example gets as a result from six pages of theory a maximum deflection, at the top of a 1,200-kw generator, 13 ft. 9 in. in diameter, of .012 in.

This small deflection is of very little importance, for in designing a machine a difference of air-gap of 1-16 or .0626 in. is allowable. The author has said not a word about frame stress, which is the main thing for the designer.

"The frames of large machines must be calculated in relation to the air space; that is, the deflection must be calculated just as in the case of a shaft, and the frame dimensioned accordingly." This is another error, the calculation of a shaft and a frame having nothing to do with each other. In the case of a shaft for electrical machines, under normal conditions deflection is a serious matter and the stress of less importance; while in the case of a frame, just the opposite is true, as I have stated above.

The structural frames of Siemens & Halske may be a commercial success in Germany where labor is cheap, but I doubt if this would apply in America on account of the high cost there of labor. There undoubtedly the cast frame of iron or steel will continue to be preferred.

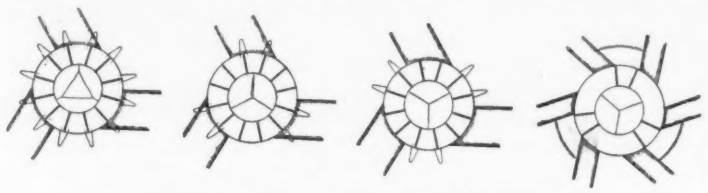
P. J. FRENELL.

BERLIN, GERMANY.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Heyland Machines Without Closed Connections Between the Segments.—HEYLAND.—An illustrated description of a recent improvement made in his machines. Fig. 1 represents the original arrangement for a compensated three-phase machine; the connections between the different segments are represented by fine lines. These connections between the segments offer practical difficulties, especially in multipolar machines, as the calculation gives in many cases large values for the resistance of these connections which, therefore, must be made long and of small cross-section, so that they cannot be easily placed on the commutator. It is, however, possible to omit some of these connections if care is taken that the breadth of the interrupted segments is smaller than the breadth of the brushes. This improvement is shown in Figs. 2 and 3, where some of the



FIGS. 1, 2, 3 AND 4.—HEYLAND MACHINES.

connections between the segments are left out; Fig. 2 shows the main position in which some connections between the segments are open; Fig. 3 shows the moment of commutation in which the segments between which there are no connections, are bridged over by the brushes. It is even possible to omit all connections between the segments; this is shown in Fig. 4, where each brush is divided into two brushes connected together by a resistance; the distance between the brushes is so chosen that at the moment of commutation the point of interruption is bridged over by the brushes. This arrangement has the advantage that it is easy to regulate the resistance properly. He gives some formulas showing that by this arrangement the shunt losses can be made as small as desired.—*Elek. Zeit.*, March 19.

REFERENCE.

Small Motors.—KIMBALL.—An illustrated article on the historical development of the small electric motor.—*Eng. Mag.*, April.

LIGHTS AND LIGHTING.

Pressure in the Mercury Arc.—STARK AND REICH.—An account of experiments in which they determined the pressure in the mercury arc by attaching a manometer tube direct to the mercury vessels. They find that if the mercury arc plays in a tube without a condensing vessel, the vapor pressure rises rapidly in the first two minutes. When the glass tube has grown so hot that small mercury droplets evaporate inside, the pressure rises rapidly from 2 mm to 10 mm. At the same time the current decreases and the difference of potential of the electrodes increases. If, on the other hand, the tube is provided with a condensing attachment then, on closing the circuit, the vapor pressure increases during the first few minutes to some 5 mm, and remains steady after that. The condensing vapor, as it enters the condensing vessel, glows with a reddish color, and shows the same spectrum lines as the arc, except that the less refrangible lines are accentuated. The condensing vapor is, therefore, cooler, but still hot enough to glow. As the difference of pressure between the arc and the condensing vessel increases, the condensing vapor contracts more and more into a sheaf, and finally becomes a cylindrical pencil. While it is still a divergent sheaf it shows a kind of stratification.—*Phys. Zeit.*, March 1; abstracted in Lond. *Elec.*, March 20.

New System of Electric Illumination.—An editorial note on the "Linolite" system which consists of a "line o' light," produced by a series of straight tubular lamps carried in a semi-cylindrical reflector. The lamps are each 9 in. long, with straight filaments—except in the case of some with a single curl at the center—and one contact plate at each end. They are held in spring holders of simple construction and in concealed brass terminals, highly plated, in the type used for theatre, shop and all internal lighting. The leads are carried in the beading at either side of the reflecting trough, and are looped into the spring contacts; for 100 to 120 volts the lamps are all in parallel, while for higher pressures they are arranged two in series. The reflector measures about 2¼ in. deep and can be made in any desired length; the lamps can also be made of any candle-power, the power absorbed being about 3.75 watts per candle. The light is distributed uniformly over an angle of 180° and gives a brilliant effect when seen directly; it is, however, preferable in applications such as shop window lighting, for which the system is especially suitable, to direct the light from the spectator toward the goods exhibited, so as to avoid glare. The reflectors are made either of nickelled copper or polished aluminum.—Lond. *Elec.*, March 20.

POWER.

Electric Shop Drive.—A full report of a recent discussion before the Eng. Club of St. Louis. Layman outlined the various methods of electric shop drive. There are two general systems, the group and individual tool system; the former may be termed a compromise between the old and the best of the new. In its best adaptions, group drive is so arranged as to have various classes of machine tools subdivided into groups of from 6 to 10 tools, each group being operated by a single motor. Where variable-speed service of tools is necessary, the individual motor system is the ideal one. The disadvantage of alternating-current motors is the lack of a satisfactory speed control. With alternating current, shop lighting from the same mains which feed the motors, is possible and commercial, while with the prevailing methods for variable-speed, direct-current motor drive the shop lighting system is practically entirely independent of the motor service system. With the aid of diagrams he discussed at some length the rheostatic control and the multivoltage systems. Cooper discussed the subject of speed variation at great length and pointed out that a really perfect speed-changing device is still missing; in conclusion he indicated the following rules to be used in determining relative sizes of motors for constant horse-power application: the total range of speed, using both variable voltage and field regulation, will be as the square of the range of voltages; change of horse-power will be directly proportional to change of voltage in armature, field being constant, the change of horse-power by change of field strength will be inversely proportional to the change in speed, the voltage on armature remaining constant; the relative size of the motor as referred to the maximum speed will be directly proportional to its speed variation when using variable voltages; the relative size of the motor as referred to the maximum speed will be as the square of the speed variation when using field regulation. While Layman

made a strong argument for constant-speed, direct-current motors and mechanical means between motor and tool for speed variation, Schwedtmann thinks that the most satisfactory system for the greater percentage of shop work is to use multiple voltage, direct-current motors or motors in which variation of speed is obtained by changing without the use of resistance the voltage across the armature or field. He finally described some methods for speed variation in alternating-current systems. Ganz & Co. are running their whole shop with two-speed, alternating-current motors; the motors are their standard two or three-phase machines; wires from two generators furnishing 50 and 25 cycles respectively are taken to each motor; on the higher frequency the motor runs without transformer; on the low frequency a transformer is inserted, reducing the voltage to a point where the best efficiency and magnetic density is obtained in the motor; this system offers all the advantages of a two-circuit, multiple-voltage control system. At the shops of the Oerlikon Company the same results are obtained in a different way; only one set of wires from one generator is taken to the alternating-current motors which have short-circuited armatures and two sets of field winding, one with double the number of poles of the other; nearly the whole Oerlikon shop is driven with this system. Schwedtmann thinks that a combination of the two systems of Ganz and Oerlikon would give all the advantages of the best multiple-voltage control system.—*Jour. Eng. Soc.*, January.

REFERENCE.

Water Power in South Africa.—FOSE.—An illustrated article on the Victoria Falls of the Zambesi River, with some remarks on their possible electrical development.—*Cassier's Mag.*, April.

TRACTION.

Northern Ohio Interurban Lines.—A description of the formation of an electric trunk system of which the Columbus, Dayton & Marion Railway is the nucleus. The system is now being rapidly extended in several directions, and it is proposed eventually to furnish through routes between Cleveland, Toledo, Columbus and other Ohio cities. The principal towns served by the system have a population aggregating 168,750. Excellent terminal facilities are secured at Columbus, Delaware, Marion, Clintonville and Stratford, and in most of these towns an arrangement has been made for operating over the tracks of the local company and taking part of the local traffic. A private right of way has been secured for most of the system and where necessary the roadbed and overhead work has been entirely reconstructed to bring it up to modern standards for high-speed interurban work. There are very few curves except in the cities, and none of them are over 4°, and there are very few cuts or fills along the line. The present owners have put in some very good bridges and trestle work, examples of which are illustrated. A feature of the transmission system is the pole line with which great care has been taken owing to the fact that the transmission is at 33,000 volts. Absolutely no iron is used at the top of the pole except the through bolt which holds the cross arm; the details of construction are shown. The present power plant is a temporary installation which will be supplanted by modern equipment as soon as the lines which are now under construction are completed. The company is also building several sub-stations, which will eventually be operated from the Marion power station.—*St. R'y Jour.*, March 21.

Interurban Electric Railways.—GONZENBACH.—A second article on engineering preliminaries for an interurban electric railway. The writer treats particularly of the location and acquirement of the right of way for railways of this character, the construction of the roadway and track, the selection of rolling stock and equipment, and the provisions required for safe operation. The size and weight of the track rail and the characteristics of the contact rail as well as the conductivity of both are discussed in detail. The writer discourages the use of the highway for the reason that numerous stops are necessary and this precludes the possibility of attaining high schedule speed; moreover, the highways as a rule do not mark the most direct routes between the points desired to be reached. The necessity for good construction of roadbed and the adoption of a type of track construction that will meet all the requirements of the service are emphasized; at the same time the writer points out that there is a marked tendency to use much heavier rail than is absolutely necessary and that considerable saving may be effected, without decreasing the value of the property, by a careful investigation of the absolute requirements of the equipment to be used. Special attention is called to the fact that there are no reciprocating parts on an electric car, and consequently there is none of the hammering to test the strength of the rail, as in the case of steam railroads employing locomotives. Attention is also directed to the fact that the heaviest electric cars in use to-day are much lighter than the ordinary steam locomotive, and that the present weight is not liable to be increased materially for ordinary interurban service.—*St. R'y Jour.*, March 14.

REFERENCES.

Brooklyn.—An article on some interesting work on the Brooklyn Elevated. Where one elevated line in Brooklyn crosses another there was so little clearance that the motor cars could not be equipped with trolley poles. The third rail is used on the elevated, but trolley poles were needed after the cars have left the elevated structure in the suburbs and run on the surface. Up to the present, trolley poles have been carried on the trail cars, but the structure has been raised so that they can now be carried on the motor cars. The method of raising the structure is described.—*St. R'y Jour.*, March 21.

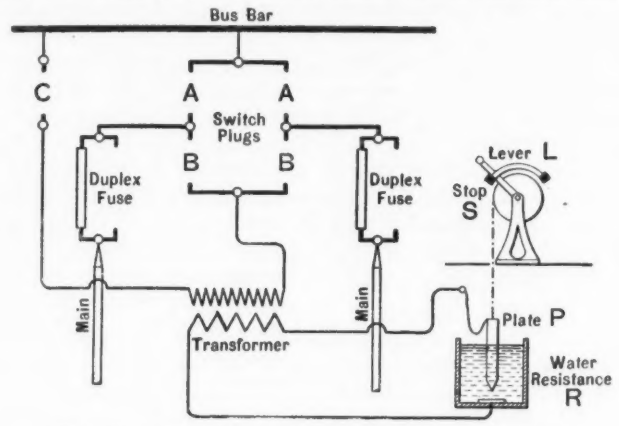
Electric Railway Bridges.—WATSON.—An illustrated paper on the construction of bridges for interurban electric railways.—*Jour. Ass. Eng. Soc.*, January.

Storage Batteries for Sub-Stations.—An article in which the writer refers to an editorial in a former issue on "Storage Batteries in Sub-Stations," and states that he does not believe that the use of batteries in sub-stations will reduce the amount of other machinery required in the same proportion as stated in that issue.—*St. R'y Jour.*, March 21.

Station Operation in Dublin.—An article in which detailed figures are given on the operation of a station in Dublin, in which the cost per kilowatt-hour is 0.7624 cents.—*St. R'y Jour.*, March 14.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Charging and Discharging High-Tension Cables.—PARTRIDGE, ORTON, NORTHCOTE, GARRARD.—Several other communications on this subject which has been discussed for some time in the correspondence columns of Lond. *Elec.*, as noticed in the Digest. Partridge considers that some sort of apparatus is essential for this purpose, but not in the shape of lightning arresters or spark gaps, but some arrangement which prevents the rise taking place. In Deptford he used the following device which has worked perfectly; it has been in daily use for the last ten years, and there was never a rise in pressure on the mains, although they are put on and taken off every day in the year. It is shown in the adjoining diagram. To charge a main switch, the switch-plug, *C*, is first closed, which connects one pole



CHARGING AND DISCHARGING HIGH-TENSION CABLES.

of the transformer to the bus-bar. The switch plug, *B*, of whichever main is to be charged is then inserted. The plate, *P*, connected to the low-tension side of the transformer, is then lowered into the liquid resistance, *R*, by means of the lever, *L*. When this is lowered to the correct position which is marked by a stop, *S*, the plug, *A*, is put in, which short-circuits the apparatus, and plugs *B* and *C* are then removed. When a main is taken off, the lever, *L*, is put over to its stop, *S*, and the plugs, *B* and *C*, are put in. The plug, *A*, is then removed and the lever, *L*, pulled over to the other side, which gradually discharges the main. The time taken to connect up the entire apparatus and either charge or discharge a main is about half a minute. —Lond. *Elec.*, March 6. Orton emphasizes the damage which will occur to transformers, motors, etc., connected directly to the high-tension mains when sudden surgings of current and corresponding rises in e.m.f. occur, due to a short circuit, a bad synchronism of an incoming machine, etc. The static interruption of Thomas (Westing-

house Company) is referred to as an actual protection, also when the mains are being connected or disconnected. To protect the cables themselves, either spark-gaps or a water-charging resistance can be used; he prefers suitably designed spark-gaps. Northcote points out that pressure rise in cables depends on several things, and their relative properties, namely capacity, resistance, frequency and self-induction.—Lond. *Elec.*, March 13. Garrard defends the use of water resistances. He agrees that only such an arrangement should be used which prevents the rising taking place, and not one which should safeguard the system after the rise has occurred. He thinks that with any arrangement, such as that of Partridge, in which transformer is combined with the cable to be charged, is liable with certain combinations of capacity and self-induction, to do more harm than good, and that the only method in which it is impossible for a bad effect to result is the use of a non-inductive resistance. He says the mechanical difficulties in the construction of water resistances are very small; with good china insulators one can insulate everything and no difficulty has been experienced in this direction.—Lond. *Elec.*, March 20.

Insulation Tests of Networks and the Earthing of the Middle Wire.—An editorial calling attention to the great importance of constant tests of the insulation resistance of a network. Reference is made to a recent paper by Taylor in which he describes a method; some older ones are also mentioned. The actual value of the insulation resistance of a network may be calculated by momentarily removing the earth connections on the middle wire and connecting an ammeter or voltmeter successively between the two of the bus-bars and earth. A second method is to connect an ammeter in series with a resistance (or high-resistance ammeter) between the middle wire and earth, and shunt it with an equal resistance, the insulation of the network being again calculable from these two readings. This latter test does not necessitate an additional ammeter to that ordinarily connected between the middle wire and earth if this instrument has a sufficiently long range or is provided with appropriate shunts. Russell has indicated a modification of these methods. The method of earthing the middle wire is then discussed. Direct earthing is not to be recommended in any case, and the most advisable plan appears to be to earth the middle wire bus-bar at the station through the ammeter referred to above and a fuse, the fuse being shunted by a resistance capable of carrying a fairly heavy current. If an earth develops or one of the outer mains the fuse blows, and the resistance is placed in circuit and saves the otherwise inevitable "short." Some electricians prefer to place a resistance premanently in series, with the ammeter between the middle wire and earth, but it is thought to be preferable to omit this. The object of the earth connection is to maintain the voltage between one of the outers and earth at its normal value, whatever may be the fault resistances of the mains. But if the middle wire earth connection has a resistance comparable with the normal fault resistance of the mains, the potential of one of the outers above earth may be considerably higher than the voltage of the supply, and there will be danger both from possible shock and leakage. Concerning the question of fuses on the middle wire it is thought that solid links should be employed throughout for the middle wire connections, whether in the streets or house-wiring. The elimination of all fuses and switches from the middle wire is a safeguard as well as a simplification.—Lond. *Elec.*, March 13.

Synchronizer Effect.—Callis.—A brief description of a curious effect observed in synchronizing the two-phase alternators recently installed at Sheffield. The synchronizers used with the 100 frequency machines are fitted with both lamp and Evershed voltmeter, connected to the same terminals, for indicating the phase. When paralleling a machine with one already running on load, it was noticed that when nearly in synchronism, a slight difference of phase displacement of the incoming machine either ahead or behind actual synchronism, produces a very marked difference in the behavior of the lamp and voltmeter, although both are fed from the same terminals. If the incoming alternator is slightly behind in phase, "as shown by the phantom poles, produced by the arc lamp slowly traveling backwards," the voltmeter needle commences to show the phase an appreciable time before the lamp filament is even red hot. If, on the other hand, the machine is ahead in phase by the same amount, the lamp attains quite a glow before the voltmeter needle commences to move. When in synchronism, both lamp and voltmeter read apparently together. In the actual paralleling of the alternators, the best results have been attained when the incoming machine is slightly ahead in phase, the switches being closed when the lamp shows full brilliancy. He says the matter cannot be explained on the general ground that the voltmeters are, to a certain extent, inductive, while the lamp is not.—Lond. *Elec. Rev.*, March 6.

Distribution Losses in Electric Supply Systems.—Constable and Fawcett.—The first part of a paper read before the (Brit.) Inst. Elec. Eng. Few central station engineers expect to get paid for more than 75 per cent. of the energy they generate; about 5 per cent. are used in the station itself for lighting and other purposes, and the remaining 20 per cent. are wasted. The authors discuss how this 20 per cent. waste is made up and whether it is possible to reduce this loss; the figures given by the authors refer to the Croydon electricity works. They first discuss the switchboard losses which in the Croydon station with a maximum output of only 1,250 kw, amount per year to 10,000 units. They then deal with the cable losses which are the most important and can be least easily reduced. They consist of three components; first, the Joulean heat loss in the dielectric, which is very small; second, the Joulean heat loss in the conductors, which is of greatest importance, and lends itself to fairly accurate calculation; third, the losses due to what may be called dielectric hysteresis. The Croyden cables consist of 25 miles 2,000-volt feeders, 50 miles 400 and 200-volt distributors, and 30 miles are cables; the total Joulean heat loss in the same is per year 150,600 units. The paper is to be continued.—Lond. *Elec.*, March 13.

Storage Battery Charging with Synchronous Converters.—Karapetoff.—A communication referring to the recent observation of Banti, who had found that the direct current given out by a single-phase synchronous converter, was decidedly pulsating, while charging a storage battery, and the same was almost steady, while at work on an ohmic resistance. Banti suggested as an explanation that the storage cells act like electrolytic condensers, producing a greater difference of phase between the current and the voltage of the charging current. The present author points out that a single-phase synchronous converter must always give some little pulsating direct e.m.f., because its armature reaction is a pulsating one; therefore, the field, being a little fluctuating, produces a pulsating e.m.f. on the direct-current side; small fluctuations of the e.m.f. may produce in special cases great pulsations of the current, no capacity or self-induction being necessary. The fluctuations in the case of a battery are large on account of its counter e.m.f. and its small resistance, as he shows by a simple calculation. No such pulsations can take place in two or three-phase converters, the armature reaction there being constant; the reaction consists in this case of a fixed reaction of the direct-current and a rotating one, produced by polyphase currents; the field of this last reaction rotates synchronously relative to the armature, but in the opposite direction, so that it is immovable in space, and thus produces a constant demagnetization of the field magnets. Concerning Banti's observation that self-induction diminishes the pulsations of the current while charging the battery, he shows how the lessening effect of a choking coil may be calculated. He finally suggests the following experiment to see whether his explanation is correct; if it is correct there should be a pulsating current when in Banti's experiment a direct-current, shunt motor is substituted for the battery.—Lond. *Elec.*, March 6.

Wires, Wiring and Conduits.

Earthed Metallic Sheathing for Cables.—Mavor.—A communication in which he emphasizes that the enclosing of the conductors in a continuous metallic sheathing connected to earth makes all the difference between absolute safety and imminent risk, but safety depends entirely upon the perfect continuity of the earthed sheathing, and unless the provision and maintenance of such continuity can be absolutely assured, the sheathing is not only no safeguard, but becomes in itself a source of acute danger both to shock and fire. It is easy to make regulations as to frequent testing of the earthing of the cable sheathings and switch and fuse box casing, but very difficult to enforce them, especially in mines. He thinks the only means of absolutely compelling maintenance of the required continuity of the metallic sheathing is the use of concentric cable with the uninsulated outer conductor connected to earth, and all switches, fuses and such apparatus enclosed in cast-iron boxes forming a portion of the earthed outer conductor. Prejudices exist against the use of an uninsulated conductor, but as applied to mining purposes they are unsupported by valid arguments.—Lond. *Elec.*, March 13.

Fire Hazard.—Devereux.—A paper read before the Engineers' Club of Philadelphia on some electric fire hazards. He distinguishes the

three following causes: a short-circuit, a leak, and the contact of inflammable materials with electrically-heated parts. These three causes are discussed and illustrated by examples from practice. Safety can be obtained only by the proper methods of construction, using only high-grade material. The fire hazard should always be carefully considered in an electric installation. "While the operation of electrical apparatus is burdened with many dangers under some conditions the reverse may be said when the equipment is installed by skilled wiremen guided by experienced engineers and the National Electric Code carefully applied; and it is essential, when alternations or repairs are necessary, that, as a continual safeguard, due notifications be given to the local Board of Fire Underwriters. Under these conditions electricity is as safe as any source of power and the safest source of light known to mankind."—*Proc. Eng. Club Phila.*, January.

ELECTRO-PHYSICS AND MAGNETISM.

Charge of Gaseous Ions.—J. J. THOMSON.—An account of a series of experiments made to determine the charge on a gaseous ion. The method devised in 1898 by him for this purpose and carried out by Wilson by means of the condensation-cloud device, assumes that the sudden expansion of the air leads to the condensation of water vapor which takes place on all the ions, both positive and negative. Subsequent experiments have, however, shown that when the rates of expansion does not exceed 1.31, only the negative ions are caught. The number of ions present is measured by determining the current carried by ions moving with a known velocity; this gives the produce of the number of ions by the ionic charge. Owing to the error mentioned above, the number of ions comes out about half its real value, and therefore the charge comes to twice its real value; he has, therefore, carried out experiments at various expansion ratios, and found that when the ratio exceeds 4 to 3, all the ions are brought down by the condensing vapor, and a further expansion does not add to the number precipitated. The charge of the gaseous ion is 0.00000000034 electrostatic units. The number of molecules in 1 cc of gas under standard conditions is 3.6 multiplied by the 19th power of 10.—*Phil. Mag.*, March; abstracted in Lond. *Elec.*, March 13.

Magnetic Detector of Electric Waves.—TISSOT.—A description of a magnetic detector, somewhat like Marconi's instrument, used in conjunction with a bolometer capable of measuring the thermal energy received by the antenna. He found that the detector action is a hysteresis effect and that the cores giving the best effect are those consisting of a material whose cycle of magnetization embrace a large surface. He has constructed two detectors which have a sensitiveness equal to that of the coherer. In one of them the core is fixed and finely laminated, and bears 50 or 60 turns of fine wire. A small coil of several hundred turns of the same wire is placed at the center of the first turn and joined to the telephone. The variable field is produced by the rotation of a magnet. In another form which recalls a Gramme ring, rotational hysteresis is brought into play.—*Comptes Rendus*, February 9; abstracted in Lond. *Elec.*, March 13.

REFERENCES.

Electromagnetism.—STINE.—The first part of a paper on the contributions of H. F. E. Lenz to the science of electromagnetism.—*Jour. Frank. Inst.*, April.

Barlow's Wheel.—CARVALLO.—A description of an experiment for lecture purposes, in which he drives a Barlow wheel by means of a single thermo-couple and thus transforms heat into mechanical energy.—*Jour. de Phys.*, February; abstracted in Lond. *Elec.*, February 27.

Terrestrial Magnetism.—The December issue contains a paper by Bauer on the results of international magnetic observations made during the total solar eclipse of May 18, 1900, including results obtained during previous total solar eclipses; a paper by Ferr on records of earthquakes on quickly driven magnetographs; an article on magnetic observations on land by the Austrian Navy between 1896 and 1901; and a portrait of Benjamin Franklin.—*Terr. Mag.*, December.

ELECTRO-CHEMISTRY AND BATTERIES.

Aluminum Valves. NODON.—An account of some researches on the internal resistance of electrolytic valves and their effect upon alternating discharges and telephone currents. When an aluminum anode is placed in a concentrated solution of neutral ammonium phosphates, the capacity of the valve may reach 1 farad per square centimeter of aluminum; this has the effect of considerably reducing the e.m.f. of the currents rectified. The apparent specific resistance of the liquid when the valves are open, is many times as high as the true specific resistance of the electrolyte. There is no oxide visible under the microscope while a current passes; but the aluminum always appears porous. A telephone current can be measured by rectifying it and using a direct-current galvanometer. Wehnelt interrupter phenomena may be obtained with an aluminum valve in an alternating-current circuit containing an induction coil provided with a very light trembler having a period identical with that of the current rectified.—*Comptes Rendus*, February 16; abstracted in Lond. *Elec.*, March 6.

REFERENCES.

Electrolytic Galvanometer.—HEILBRUN.—An illustrated article in which he describes some lecture room experiments for demonstrating that when a galvanic cell sends current through an external circuit, the current also flows through the electrolyte of the cell, a fact which he thinks is often doubted by laymen. He uses the magnetic effect of a coil consisting of a glass tube wound in many windings and filled with the electrolyte, and forming the only connection between the anode and the cathode compartments.—*Zeit. f. Electrochemie*, February 5.

Aluminum.—PITIVAL.—The first part of an article of the present conditions of the metallurgy of aluminum, with special references to a recent article of J. W. Richards.—*Jour. de L'Elec.*, February 15.

Aluminum.—SPERRY.—An illustrated article on the use of aluminum in the rubber industry for making moulds.—*Metal. Ind.* (formerly *Alumin. World*), February.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Core Ratio.—YOUNG.—The conclusion of his article on the ratio of resistance to capacity in long submarine cables. He discusses the best resistance of the battery for a given maximum pressure; while in automatic curb transmission direct to line, the lower the battery resistance the better, with condenser-curb sending it has a certain "best value," which is defined as follows: the best value of the battery resistance in condenser sending is the limit to which its resistance can be raised conjointly with the e.m.f., without exceeding a given maximum stress, beyond which limit the gain in amplitude of the wave is neutralized by the loss of sharpness of form. The best resistance of the receiver in direct working, varies directly as the square root of the CR per microfarad of the line for a given signalling speed. With condensers in circuit at one or both ends, the law is less simple; the higher the speed of sending the less the best resistance of the receiver; the higher the condenser capacity, the less the best resistance of the receiver. The most obvious application of the principle of resistances per microfarad, as well as the most elegant proof of the law of inverse square roots, consists in the condenser bridge or "double block" duplex system. Here the balance of the potentials on the opposite sides of the bridge depends on the equality of the pair of pressure waves, alike in amplitude and phase. Those who have to duplex long cables are well aware how a slight difference between the two waves in either respect, whether retardation of phase by too much resistance, or excess of amplitude by too much capacity, operates to upset the balance. The recorder in the cross-circuit indicates principally differences between the mean ordinates of the waves, but if rapid it will often respond first to inequalities in their maximum. In the most perfect adjustment one wave must be an exact copy of the other in the peak of maximum pressure as well as in the mean, the well-known "jar" being the indication of want of coincidence in the wave crests. What is conclusively proved, however, by observation is that a working balance, or effective equality between the pair of pressure waves, is only produced when the bridge condensers are adjusted inversely as the square roots of the CR's per microfarad of the cable and artificial line respectively.—Lond. *Elec.*, March 13.

Loaded Lines in Telephonic Transmission.—CAMPBELL.—A mathematical investigation of the effect of inserting self-induction coils on long telephone lines as in Pupin's system, and an account of some experiments. He worked with a cable circuit 46 miles in length, partly artificial, containing 100 equally-spaced inductance coils. The initial loss due to the loading was found to be equivalent to the introduction of 9 miles of standard cable, but on account of the greatly reduced attenuation, the loaded line is better than the unloaded line for all distances greater than 15 miles. In the author's arrangement, the distance over which transmission could be obtained was nearly trebled by the loading, and the quality was improved in addi-

tion. At the transmitting end a person talked in a steady, monotonous manner, and at the receiving end a person could switch instantly from the loaded line to the artificial cable standard, to compare the clearness of transmission over the two. The comparison gave the equivalents of the two circuits for commercial service. The author admits that much further experimental work remains to be done.—*Phil. Mag.*, March; abstracted in Lond. *Elec.* March 13.

MISCELLANEOUS.

REFERENCE.

Biographical.—HAWKINS.—An article on "Nikola Tesla, his work and unfulfilled promises."—*Elec. Age.*, February.

New Books.

DIE KUNSTLICHEN KOHLEN. Fur Elektrotechnische und Elektrochemische zwecke, ihre Herstellung und Prüfung. By Dr. Julius Zellner. Berlin: Julius Springer. 295 pages, 102 illustrations. Price, 9.20 marks.

Hitherto the literature of carbons for technical purposes, aside from isolated papers appearing in technical journals from time to time, has consisted of Pritchard's "The Manufacture of Electric Light Carbons" (London, 1890), and Jehl's "The Manufacture of Carbons for Electric Lighting and Other Purposes" (London, 1899). The volume before the reviewer is, then, the first exhaustive presentation by a German scientist of the results of researches conducted with characteristic German thoroughness and extending over a period of more than seven years. The subject matter of the book may be sub-classified severally as (1) the raw material, as found in the natural state and as artificially produced; (2) the actual construction of the carbons from this raw material, and (3) the testing, preliminarily of the raw material, finally of the finished product.

An important feature of the work is that exact descriptions and details of processes are given. The author, a professor of chemistry, has availed himself of the experience of his colleagues with regard to mechanical and technical aspects of the work, inevitably related to the subject in-hand, but lying outside the peculiar province of chemical investigation. The result is that the writer is not compelled to veil his ignorance of allied topics by loose and inaccurate statements. In a word, the book is thoroughly German. The numerous illustrations distinguish themselves for showing at a glance and clearly-cut, the essential features of the devices described in the text.

ELECTRICITY AS APPLIED TO MINING. By A. Lupton, G. D. Aspinall Parr and H. Perkins. New York: D. Van Nostrand Co., 280 pages, 171 illustrations. Price, $3.50.

This is a volume which appeals to the mining engineer, and is a manual that furnishes him with instructions for such electric installations as are particularly designed for various mining processes.

The first two chapters are devoted to such an exposition of electrical theory as will enable the mechanical engineer easily to comprehend the principles involved in the construction of dynamos and motors. The matter is very condensed, but on the whole presented in an exhaustive, clear and readable form, much more so than is common to elementary descriptions of the principles of electrodynamics. Chapters III and IV are occupied with a comparison between water power, steam power and gas engines, rather from the economic than from the mechanical standpoint. There are a number of tests upon plants, showing efficiency and cost of operation, which form a valuable feature.

Chapters V and VI take up the distribution of electrical energy theoretically, in the first place showing the method of designing and calculating circuits in common use, and subsequently from the construction standpoint, describing conduits, cables and line building in general. Chapters IX to XIV, inclusive, about half of the volume, are taken up with the description of the various forms of mining machinery which are driven by electricity, together with the methods of installation and operation. The last two chapters deal with a comparison of electricity with other forms of the transmission of power, and the dangers to be guarded against in the use of electricity in mining. The volume is thoroughly up to date, and the tabular matter bears the appearance of unusual care, while in style the book will address itself to the engineering mind.

BOOKS RECEIVED.

ELEKTRISCHE STRASSENBAHNEN. By Johannas Zacharias. Vienna: A. Hartleben. 240 pages, 128 illustrations. Price, 5 marks.

STEAM POWER PLANTS: Their Construction and Design. By Henry C. Meyer, Jr., M. E. New York: McGraw Publishing Company. 160 pages, 65 illustrations, 16 plates. Price, $2.00.

DIE HERSTELLUNG VON METALLGEGENSTANDEN UND DIE ELEKTROGRAVURE. By Dr. W. Pfanhauser. Halle: Wilhelm Knapp. Price, 7 marks.

EINRICHTUNGEN VON ELEKTROLYTISCHEN LABORATORIEN. By H. Nissenson. Halle: Wilhelm Knapp. 51 pages, 32 illustrations. Price, 2.40 marks.

KALENDER FUR ELEKTROCHEMIKER. Sowie Technische Chemiker und Physiker, 1903. By D. A. Neuberger. 583 pages. Beilage zum Kalender fur Elektrochemiker sowie technische Chemiker und Physiker. 448 pages. Berlin: M. Krayn. Price, 4 marks.

STORAGE BATTERY ENGINEERING. A Practical Treatise for Engineers. By Lamar Lyndon, B. E., M. E. New York: McGraw Publishing Company. 382 pages, 178 illustrations and 4 plates. Price, $3.00.

INFORTUNI SUL LAVORI. Mezzi Tecnici per Prevenirli. Manuali Hoepli. By E. Magrini. Milan: Ulrico Hoepli. 215 pages, 258 illustrations. Price, 3 lire.

CONDUCTORS FOR ELECTRICAL DISTRIBUTIONS. Their Materials and Manufacture. By F. A. C. Perrine, A. M., D. C. New York: D. Van Nostrand Company. 287 pages, illustrated, with 5 charts in cover pocket. Price, $3.50.

Directory of Electrical Societies, Etc.

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, C. J. Reed, 929 Chestnut Street, Philadelphia, Pa. Next meeting, New York, April 16, 17 and 18, 1903.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, 95 Liberty Street, New York. Next meeting, April 24th, "Tendencies of Central Station Development," H. A. Lardner, Philippo Torchio and Peter Junkersfeld.

AMERICAN ORDER OF STEAM ENGINEERS. Secretary, Frank C. Rose, 10 Federal Street, Pittsburg, Pa. Seventeenth annual convention of the Supreme Council of the United States, Pittsburg, May 11.

AMERICAN STREET RAILWAY ASSOCIATION. Secretary, T. C. Penington, 2020 State Street, Chicago. Next meeting, Saratoga Springs, N. Y., September 2, 3 and 4, 1903.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, W. H. Johnson, Philadelphia, Pa.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, Colby and Abbott Building, Milwaukee, Wis. Next meeting, New Orleans, La., May 13, 14 and 15, 1903.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Toronto, Ont., 1903.

ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, Wm. J. Davis, Ithaca, N. Y.

THE ELECTRICAL TRADES SOCIETY (Member National Electrical Trades Association). Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets every second Friday of each month.

ENGINE BUILDERS' ASSOCIATION. F. P. Ide, Springfield, Ill., Secretary.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, N. Y. Next meeting, Atlantic City, N. J., September, 1903.

INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary. E. M. Coleman, Louisville, Ky.

IOWA TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Des Moines, Iowa.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, H. K. Cole, of Lancaster, Ky.

NATIONAL ASSOCIATION OF MANUFACTURERS. Secretary, Marshall Cushing, 170 Broadway, New York. Annual convention, New Orleans, La., April 14, 15 and 16, 1903.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, Utica, N. Y. Next meeting, Detroit, Mich, July 15, 1903.

NATIONAL ELECTRIC LIGHT ASSOCIATION, Secretary, James B. Cahoon, 136 Liberty Street, New York. Next meeting, Chicago, May 26, 27 and 28, 1903.

NEW YORK ELECTRICAL SOCIETY, Secretary G. H. Guy, 104 Liberty Street, New York.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, T. R. Mercein, 85 Michigan Street, Milwaukee, Wis.

SOUTHERN INDIANA TELEPHONE ASSOCIATION. Secretary, E. W. Pichardt, Huntingburg, Ind.

McElroy System of Railway Car Lighting.

At the meeting last month of the Boston branch of the A. I. E. E., Mr. James F. McElroy described his system of train car lighting as developed by the Consolidated Car-Heating Company, of Albany. This system of lighting cars may be called a modified constant-potential system, and employs an axle-driven dynamo which is capable of operation by motion in either direction. Fig. 1 presents a view of the dynamo. The dynamo rests, at one end, upon bearings on the car axle, whilst it is supported by easy-riding springs under the dynamo body, the springs resting upon curved supporting bars attached at one end over the car axle bearings, at the other end swinging from pendulum supports to a cross-bar which rests upon the truck frame. The dynamo is, therefore, free to move with the car axle. The curved bar supports facilitate the removal of the axle and wheels, when that is necessary, by dropping down out of the truck frame in the usual manner. They also make it easy to open the dynamo as shown in Fig. 2 without, in any way, releasing the dynamo from its supports. The dynamo is driven by means of gear and pinion in a manner somewhat similar to that employed on motors of trolley cars. A wrought-iron gear case incloses the gear and pinion and is made dust-proof with leather packing.

All doors admitting to parts of the dynamo requiring inspection as well as the doors for supplying oil and waste to the axle bearings close upon leather or felt packing and are held firmly to place by strong spring latches of flat steel. All doors are in this way made dust-proof. The compartment containing the reversing switch is shown at the left and in advance of the armature bearing. This switch is operated by the armature shaft and reverses the connections of the armature to the mains. A door easily accessible admits to this chamber for purposes of inspection.

FIG. 1.—VIEW OF DYNAMO (CLOSED.)

A storage battery is employed for supplying the lamps during stops. The battery receives its charge at all times when the dynamo is in operation and the battery is below the point of full charge. The flow of current to the storage battery and the generation of current by the dynamo are regulated, through the widest variations of speed, by means of the regulator shown in Fig. 3. In this regulator a motor, through worm and gear connections, operates a rheostat which is connected in series with the dynamo fields. The motor is controlled by a compound solenoid and plunger, the plunger being connected with an arm-carrying carbon contacts by which the current is directed through the motor for changing its direction of motion.

To insure the workings of the regulator under all conditions, it is necessary that the motor should be wound for large torque and low speed and be capable of operating at a voltage as low as the lowest voltage ever carried upon a battery. It is also necessary that the changes in position of the rheostat should be made at a rate not greater than the rate at which the corresponding changes will take place in the field magnets of the dynamo, otherwise the phenomenon of racing will cause a disturbance in the lights. To prevent racing a centrifugal governor is used, by means of which the circuit through the motor is completed between two stationary rings which surround the motor shaft. Contact is made between these two rings by means

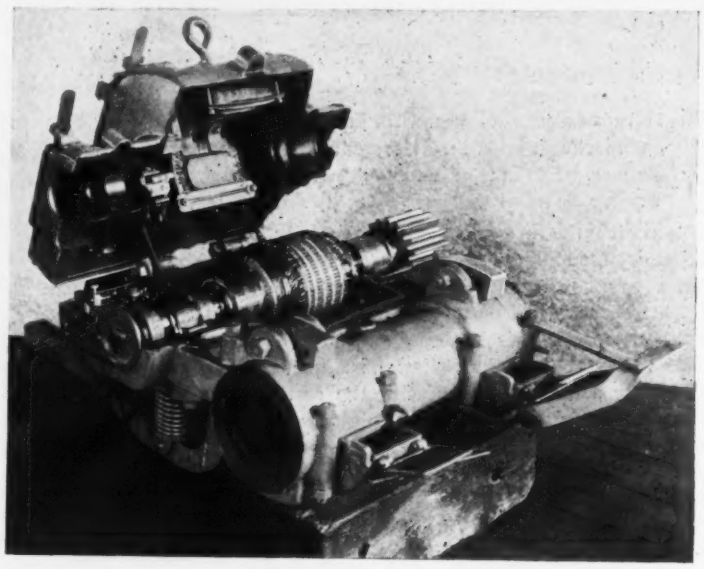


FIG. 2.—VIEW OF DYNAMO (OPEN.)

of weighted arms which, on the starting of the motor, immediately throw out and break the circuit. The result is that the governor gives to the motor a fixed rate of motion and this rate of motion is not increased or decreased within the limits of voltage at which the motor operates. The centrifugal governor is mounted above the motor and within the perforated hood at the top of the regulator.

In the construction of this regulator the compound solenoid is placed inside an iron envelope which receives its support from the metal framework to which all of the working parts of the regulator are attached. The iron envelope increases the pull of the solenoid more than double by furnishing a magnetic covering through which the magnetic flux is conducted back outside of the coil. At the ends the iron envelope is kept back from the plunger a distance of nearly three-eighths of an inch to prevent the envelope from creating a side pull upon the iron plunger. Longitudinal ribs are cast on the iron casing for the purpose of furnishing a path in the direction of the magnetic flux and at the same time for increasing the surface of the iron casing to permit of the ready escape of heat that may be generated in the solenoid. The enlarged pull upon the plunger, due to the improved path for the magnetic flux and the fact that the regulation is effected both by means of change of voltage and change of current to the battery, renders the apparatus very sensitive and positive in its action.

The switch for disconnecting the dynamo from the storage battery is operated by the motor which drives the rheostat. The return of the rheostat to the home position when the field resistance is all out opens the switch and disconnects the dynamo. In starting the dynamo, when the dynamo voltage equals the lamp voltage, the first motion of the rheostat closes the switch and connects the dynamo and storage battery together. A further rise of voltage causes the lamp resistance to be inserted step by step between the battery and lamps and the battery begins to receive its charge.

The lamp resistance is shown more clearly in diagram of connections in Fig. 4. The sections of this resistance are inserted as the voltage of the dynamo rises, causing motion of the rheostat arm from its home position. The proper fall in voltage from that required for the storage battery to the lamp voltage is thus secured. The lamp voltage is that which the storage battery is capable of maintaining when the dynamo is not in operation. As the lamps are

divided into two circuits, each circuit has its own lamp resistance, which is inserted step by step by the rheostat arm.

Vestibule lamps are provided so as to give an abundance of light upon the steps and in the vestibules of a car when the train comes to a standstill. These lamps are preferably connected across the cut-out switch separating the dynamo from the storage battery. The current for the vestibule lamps, therefore, flows from the storage battery through the dynamo and lamps in series. These lamps are lighted solely by the difference of the e.m.f. of the dynamo and stor-

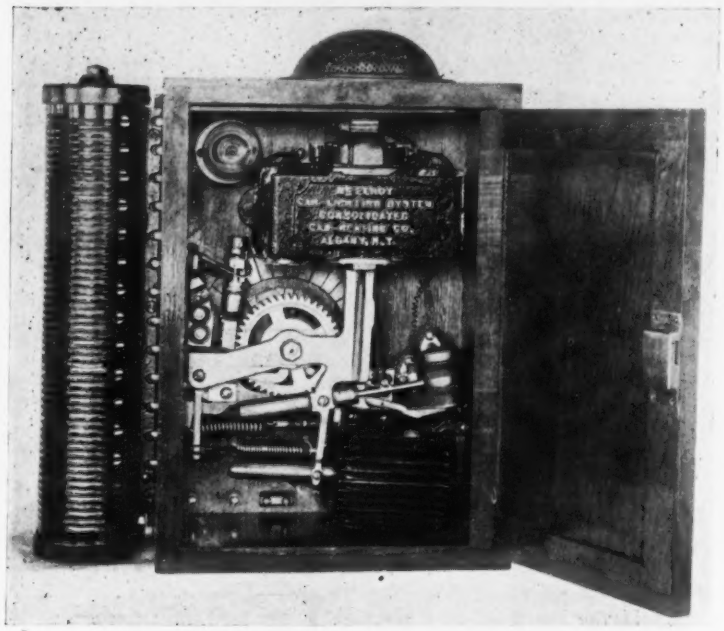


FIG. 3.—VIEW OF REGULATOR.

age battery. They are, therefore, lighted automatically when the speed of the train drops below twelve miles per hour and come to full intensity at very slow speeds and during stops. As these lamps do not draw upon the lighting apparatus during long runs, they can be made of ample intensity to furnish an abundance of light over the steps of a car at the time when the steps are in use, and at the same time do not draw upon the lighting apparatus at times when the lights in the vestibules are not needed.

The motor of this regulator performs a series of operations in a preearranged order. In the act of stopping a train the rheostat moves to its home position and cuts out the resistance in series with the field coils of the dynamo. As it approaches the home position it cuts out the lamp resistance and automatically changes the tension of the regulator spring to change the adjustment of the regulator from the voltage of the dynamo when charging the battery to the voltage of the lamps. When the dynamo voltage reaches the lamp voltage, the motor opens the switch between the motor and storage battery. A further movement of the motor opens up its own circuit so that when the car is at a standstill there is no circuit through any part of the regulator or dynamo through which the current of the storage battery is wasted. However, all parts of the regulator are then in proper position so that when the dynamo current picks up and excites the solenoid, the effect upon the plunger is to first re-establish the circuit through the motor which is done at the carbon contacts; second, it closes the circuit between the dynamo and storage battery and then third, a further rise of voltage of the dynamo causes the regulator to insert resistance in series with the lamps and in series with the field coils of the dynamo.

In this regulator no motion of any of its parts takes place except when necessary to meet some change in the condition of the lighting system. When the train is running at a constant speed, the regulator is motionless. When speed increases a slight motion takes place just sufficient to introduce the proper resistance in series with the dynamo fields to maintain the voltage constant. In this way there is the smallest wear of moving parts and the least possible care is required to keep the mechanism in order.

As has been stated above, the regulator is controlled by a compound solenoid. By reference to Fig. 4 it will be seen that the compound solenoid is made up of two coils, one a large shunt-wound coil connected between the dynamo mains, and the other a small series coil which is connected between the main and the storage battery. These two coils act in conjunction when the dynamo is supplying current to the storage battery, and are opposed to each other when the storage battery is giving out current. The compound solenoid draws the plunger against the tension of a spring. A motion of the motor always takes place when the pull of either the solenoid or the spring predominates and causes the carbon contacts to close the circuit through the motor. The total of the effects of the two coils upon the plunger is equivalent to the tension upon the resisting spring.

It is evident that when the storage battery is nearly depleted, the rush of the charging current into the battery through the series coil will cause the series coil to increase its pull upon the plunger and hence reduce the voltage at the terminals of the shunt coil. In this way the excessive flow of current into the depleted battery is prevented. However, as the charging operation proceeds and the counter e.m.f. of the battery increases, the decreased flow through the series coil to the battery will decrease the magnetic effects of the series coil and the voltage at the terminals of the shunt coil will correspondingly increase. As the counter e.m.f. of the battery continues to increase, the decrease in the flow to the battery will slowly but gradually cause a rise in the voltage on the mains. When the battery begins to gas and the voltage of the battery rises abruptly the shunt coil will assume almost the entire control over the regulator and the current through the series coil to the battery will reduce to not over 5 to 10 per cent. of the original charging rate, this being deemed just sufficient to cause the battery to slowly gas and replace battery losses or leakages. In this condition the apparatus may be used on a car having a daylight run and with practically no load upon the dynamo after the battery has become fully charged. It is also used, without readjustment, upon cars operated

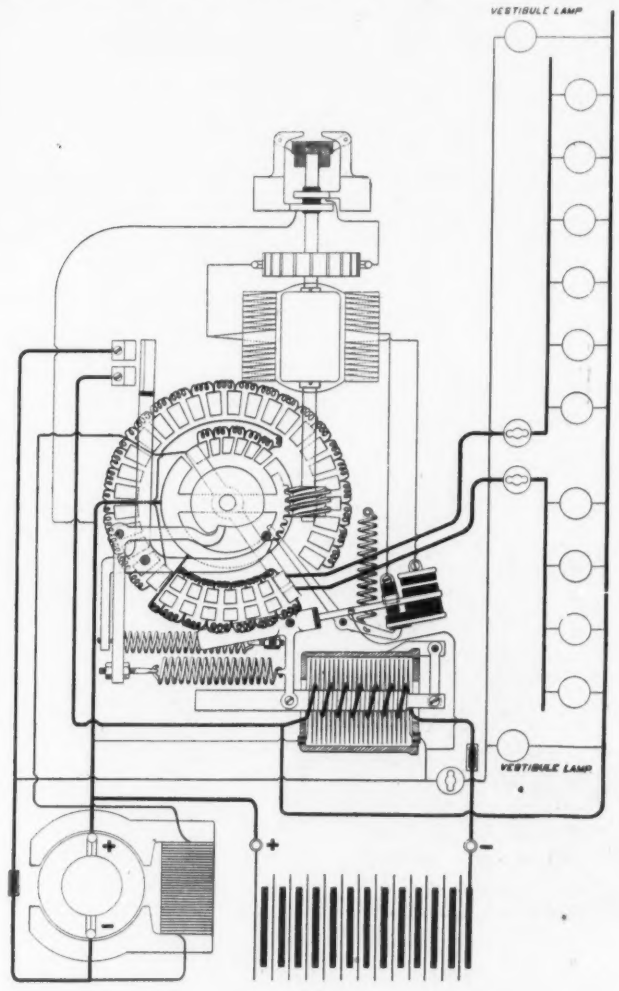


FIG. 4.—DIAGRAM OF WIRING WITH REGULATOR.

wholly at night with all lights in use. With this simple device the charging of the storage battery is made automatic and by proportioning the number of ampere-turns of the series and the shunt coil, the charging rate may be made to follow any formula that the battery maker may prescribe. It will also be seen that with this method of regulation we avoid the dangers of both the shunt and the series methods of regulating the charge to the storage battery.

Cooley Cycloidal Engine.

If the path of a point is developed by simultaneous circular motions about parallel non-coincident axes, this path may have any one of the shapes that lie between the circle and the straight line. By the application of this principle to steam engines and machine tools, the Cooley Cycloidal Engine Company, of Boston, Mass., is producing some notable results. In a small machine built to illustrate the principle in question, a revolving table with a circular sheet of paper attached is located beneath a revolving spindle with three markers. The axes of the revolving table and the spindle are parallel and may be made coincident or not as desired. By means of this little machine the circle, the square, the triangle, the straight line, and an infinite number of intermediate shapes are described on the paper held by the revolving table.

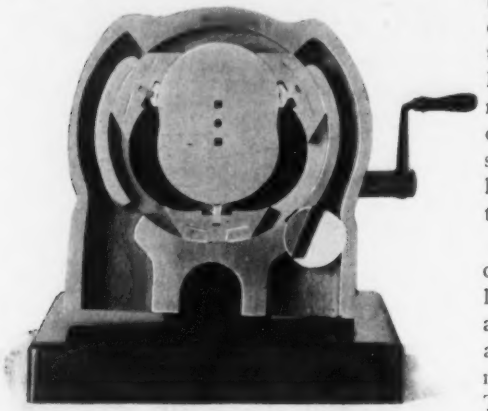


FIG. 1.—SECTION OF ENGINE.

In the application of this principle to a lathe, both the work and the cutter revolve about parallel, but non-coincident axes. Two simple circular motions thus combined make it possible to turn a bar of square, triangular or polygonal shape, and to have corresponding holes. A desirable application of the ability to turn and bore square might be found in the case of armature shafts, spiders and couplings where a square fit would be much superior to a round fit with a key.

As applied in the design of a steam engine, the foregoing principle results in the production of a prime mover with simple rotating parts, a practically unlimited range of speed, and great power in terms of bulk and weight. In general outline, this type of engine is a cylinder that tapers to a bearing at each end for the central working shaft. In speed these engines are said to be only limited by the strength of their parts, and they may be operated at any rate of revolution between that of the fastest steam turbine and that of a slow reciprocating engine. The engine is entirely destitute of reciprocating parts. As to allowable steam pressure, it is said that

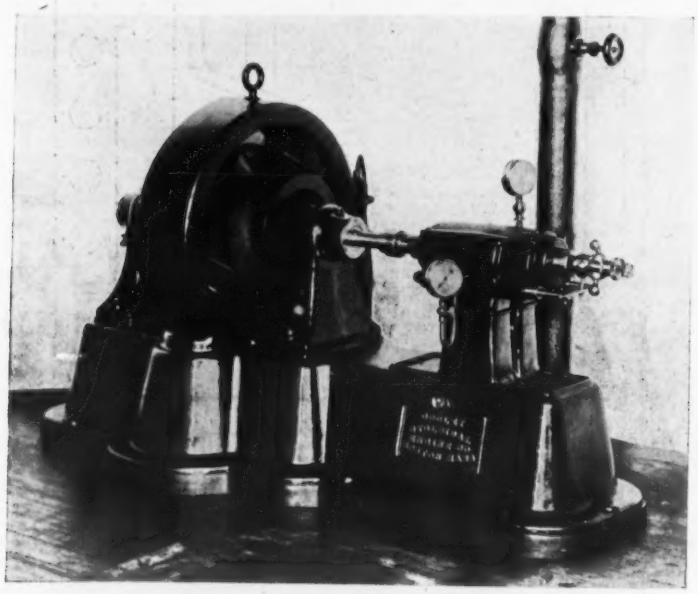


FIG. 2.—10-HP ENGINE AND 6-KW DYNAMO.

these engines are subject to only such limitations as apply to the ordinary types. While the Cooley engine is workable through a range of speed which includes those of all other types, the power of any particular size varies directly with its rate of revolution and approximately as the steam pressure employed.

Illustrating the small bulk and weight of these engines per unit of capacity, it may be said that the size rated at 10 hp with 200 pounds of steam pressure when operating at 2,000 r.p.m., has a weight of 70 pounds and measures approximately 6 in. in diameter by 14 in.

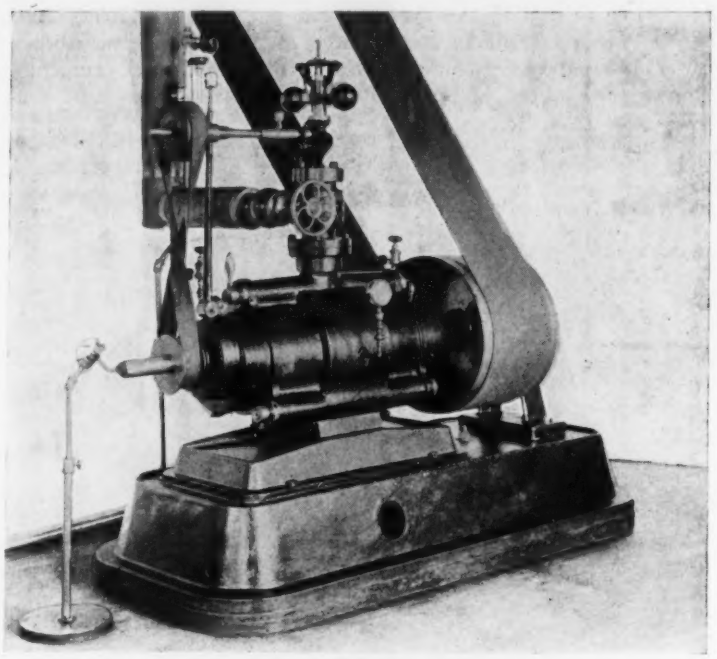


FIG. 3.—70-HP ENGINE.

long. If the speed of this machine is reduced to 1,000 r.p.m., it yields 5 hp with 200 pounds steam pressure. Compared with that of a dynamo having equal capacity, the bulk of one of these engines is very small, as may be noted in the case of a four-pole, 6-kw, 950-r.p.m. dynamo, direct-connected to an engine in the testing room

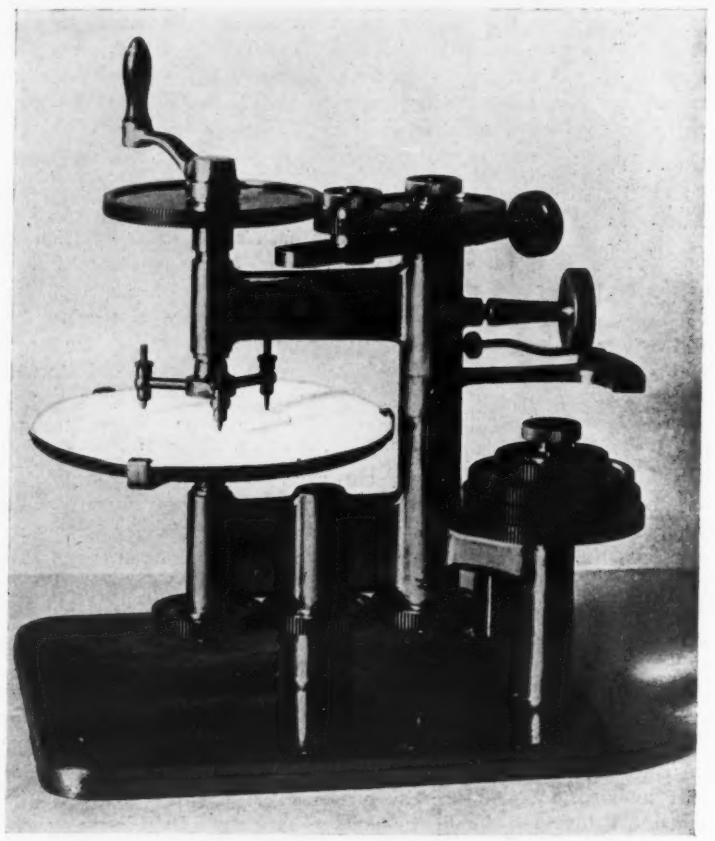


FIG. 4.—MACHINE TO ILLUSTRATE PRINCIPLE OF COOLEY INVENTIONS.

of the Cooley Compnay. The speed of these engines is regulated by either automatic or throttling governor, as desired, and in order to operate the same engine at widely different speeds, it is only necessary to change the governor. A striking feature of the engine is the ease with which it can be reversed in its direction of rotation by the simple turn of a lever when operating at very high speeds.

For the highly important matter of efficiency tests on its engines the Cooley Company has made unusually elaborate and complete provisions in its shops at Allston, a suburb of Boston. These facilities are placed at the disposal of those who may wish to test the engines with a view to their use. In the testing room are several iron plates on which engines can be operated, three dynamos ranging from 6 to 70-kw capacity, a large bank of lamps with a convenient

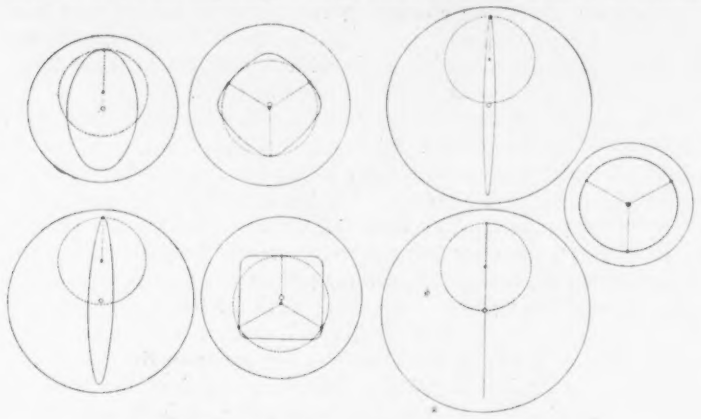


FIG. 5.—FIGURES TRACED BY ILLUSTRATING MACHINE.

arrangement of switches, and an equipment of volt and ampere meters. Beneath the testing room and in other parts of the basement there are a steam boiler devoted to testing purposes, a Worthington condenser, with pump, and the necessary piping to deliver the engine exhaust to a pair of tanks mounted on large Fairbanks scales. The completeness of all this equipment for the execution of economy tests on engines is seldom equalled outside of technical schools. An interesting piece of apparatus for exhibition purposes comprises a 10-hp engine mounted to drive a propeller wheel in a large tank of water with a glass side. Prof. Edw. F. Miller, of the Massachusetts Institute of Technology, has made a number of tests of engines for the Cooley Company at its shops. In one of these tests, lasting from 5.06 to 6.36 P. M., on March 4, 1903, a nominal 10-hp engine direct-connected to a 6-kw dynamo was concerned. According to the report of this test, the boiler pressure varied between 162 and 174 pounds, and the vacuum in the condenser varied from 12 to 23.8 pounds per square inch.

The average brake horse-power delivered by the engine to the dynamo during the test was 10.5, and the steam consumed by the engine per horse-power-hour was 42.8 pounds. In another test, extending from 4.42 to 5.42 P. M., on February 28, 1903, an engine rated at 70 hp, with 200 pounds steam pressure, was operated on a partial load consisting of shafting and a dynamo supplying lamps. During this test the boiler pressure ranged between 86 and 145 pounds and the vacuum in the condenser connected with the engine was as low as 14 and as high as 20 pounds per square inch. The average rate of work delivered by the engine during the hour of operation was 19.6 hp and the weight of steam consumed per horse-power-hour was 33.4 pounds. It is fair to presume that this 70-hp engine would show better economy at nearly full load. Both of the foregoing tests were made on simple engines without jackets, and there is no doubt that insulating jackets and compounding would lower the rate of steam consumption.

The Cooley Company is building an engine of 150 hp for the Massachusetts Institute of Technology, and has also under way an engine for locomotive use that will yield 600 hp when used simple and a much greater capacity when compounded. A few engines are built by the Cooley Company for purposes of exhibition and testing, but the main business of the company is the sale of rights to apply its inventions to engines, machine tools, and for other purposes. In the shops of the company are a number of machine tools fitted with its devices for turning and boring special shapes, and these tools, together with the complete plant for engine testing, are open to any one who wishes to investigate the merits of the apparatus.

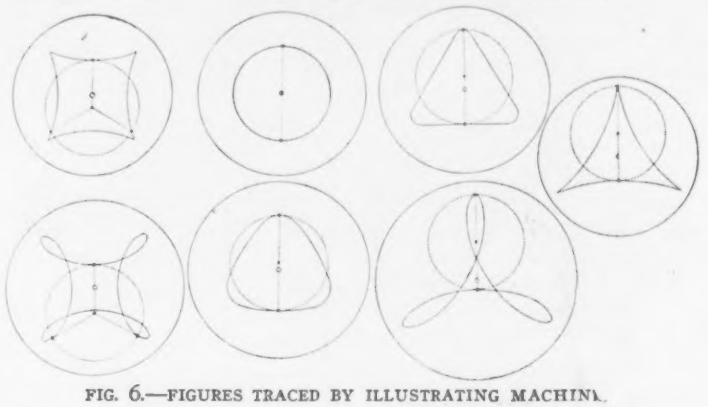


FIG. 6.—FIGURES TRACED BY ILLUSTRATING MACHINE.

The matter here presented has been obtained through the courtesy of Mr. John F. Cooley, manager of the company. The characteristics of the above prime mover are such that dynamo builders and users will watch its future development with no little interest.

Railway Brake Air Compressors.

The accompanying illustrations refer to the General Electric system of railway car air braking. The compressor consists of two main parts—the motor end and the compressor end. The motor is similar in design to the General Electric box frame type of railway motors. The unsplit magnet frame has frame heads at each end which support the armature shaft bearings. At the compressor end, horizontal single-acting tandem cylinders are cast as a part of the frame head. The armature shaft bearing at this end is specially large in diameter, and the crank pin formed at the end of the shaft is located just inside the bearing diameter. By removing the four bolts which fasten the combined frame head and cylinders to the magnet frame, and taking off the retaining washer at the end of the crank pin, the compressor can be separated from the motor. On the removal of the compressor the armature can be taken from the magnet frame.

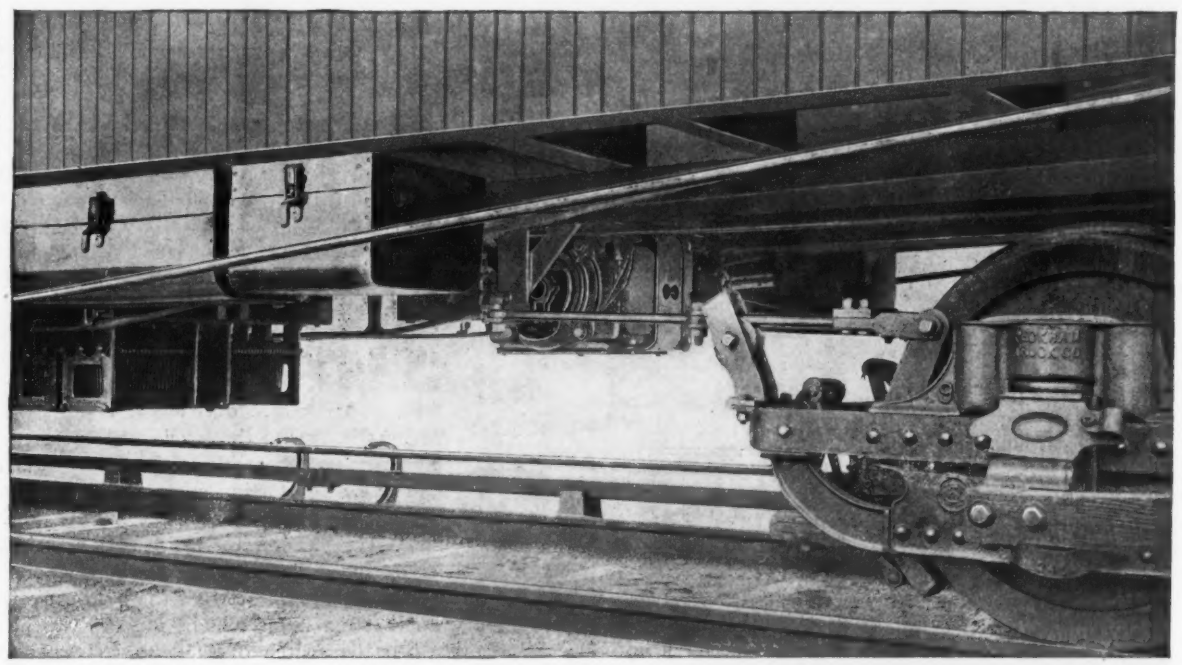


FIG. 1.—AIR COMPRESSOR MOUNTED ON A CAR.

Working in the tandem cylinders is a single double-ended piston actuated by a single connecting rod, which connects the crank pin to

a wrist pin located at one end just back of the piston head. By removing one of the cylinder heads, the piston can be drawn out.

The magnet frame is cast-steel, unsplit, and cubical in shape with well rounded corners and inwardly projecting poles. There are a number of openings fitted with malleable iron covers which permit of easy inspection and access to the commutator and brush-holders. With covers on, the motor is completely enclosed. Under service

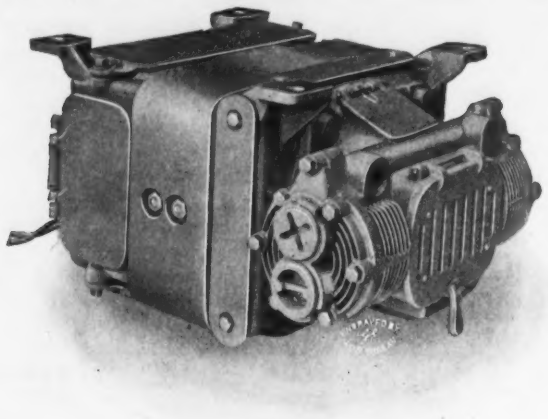


FIG. 2.—AIR COMPRESSOR—COMPRESSOR END.

conditions which will permit of it, the covers can be left off for ventilation if desired.

There are large openings in the ends of the frame through which the armature can be easily put in place. The openings are filled with the frame heads which support the armature crank shaft bearings. As stated above, lugs or feet for supporting the outfit are cast on the frame.

The frame heads project well within the armature, this construction permitting long and liberal bearings, without sacrificing the compactness of the compressor. At the commutator end of the motor, the frame head is accurately bored to receive a sleeve bearing lining. A large well, fitted with a spring-hinged cover, is cored in the head to receive oil to lubricate the bearing.

The frame head at the compressor end is cast in a single piece with the compressor cylinders. The head carries a large lining for the shaft bearing and has provisions for lubrication similar to that on the commutator end.

The two compressor cylinders are cast in a single piece with the compressor end frame head which carries the shaft bearing and oil well. The exterior of the cylinders is well ribbed to radiate the

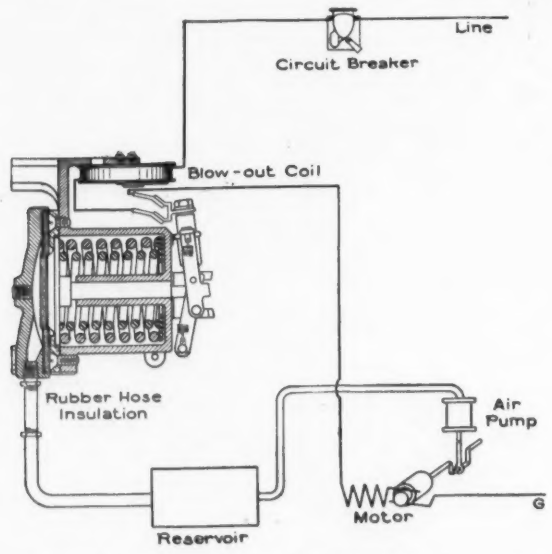


FIG. 3.—CONNECTIONS OF AIR COMPRESSOR GOVERNOR.

heat generated during compression, and the interior surfaces are accurately bored in alignment. The extension of the casting between the cylinders forms an enclosed chamber hollowed at the bottom to receive a quantity of oil for the lubrication of the cylinders and the connecting rod bearings. The parts may be inspected through an opening in the front which is provided with a hinged cover.

Each cylinder head contains two bored chambers which contain the valves. A large plug screwed against a copper gasket closes each chamber and allows easy removal of the valves. Liberal passages are cored in the casting around the outlet valve, connection being made with an air passage between the cylinders.

The trunk piston consists of a single casting with a head at each end, and hollowed in the central portion, leaving strong ribbed sections. Within the space between the heads, the connecting rod and crank pin play, forming a very compact construction. The wrist pin on which the connecting rod pivots is located just back of one of the piston heads. The pistons are accurately turned and grooved for cast-iron packing rings with lapped joints. This design insures accurate machining and perfect alignment.

The valves are composed of small, light disks, playing noiselessly, with small clearances and minimum leakage. They operate on accurately machined seats within a steel casing. There are no springs or complicated parts to deteriorate under the high temperature of compression. The inlet and outlet valves are the same in general design, the seats being merely reversed in position.

Aside from the contact between the pistons and the cylinders, there are but four bearings—two armature shaft bearings and two connecting rod bearings. The shaft bearings consist of brass sleeve linings, cut away on the sides to allow oily waste in the oil wells to press directly against the shaft. The slow speed of the armature and the liberal dimensions of the parts insure a long life for the bearings. Oil deflectors on the shaft prevent oil from getting into the interior of the motor. The overflow is caught in channels leading to suitable drip cups cored in the castings beneath the bearings.

An effective method of lubricating the cylinders and connecting rod bearings is furnished by a finger, fastened to the end of the crank

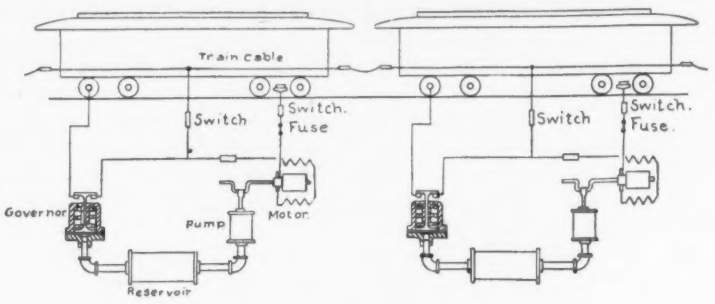


FIG. 4.—CONNECTIONS OF AIR COMPRESSORS ON TRAIN OF CARS.

pin, which in rotating through the oil at the bottom of the compressor chamber distributes it over the bearing surfaces.

Fig. 2 is a view of a compressor from the compressor end and Fig. 1 shows a compressor mounted on a car. Fig. 3 shows the connections of an air compressor governor and Fig. 4 the car and train connections.

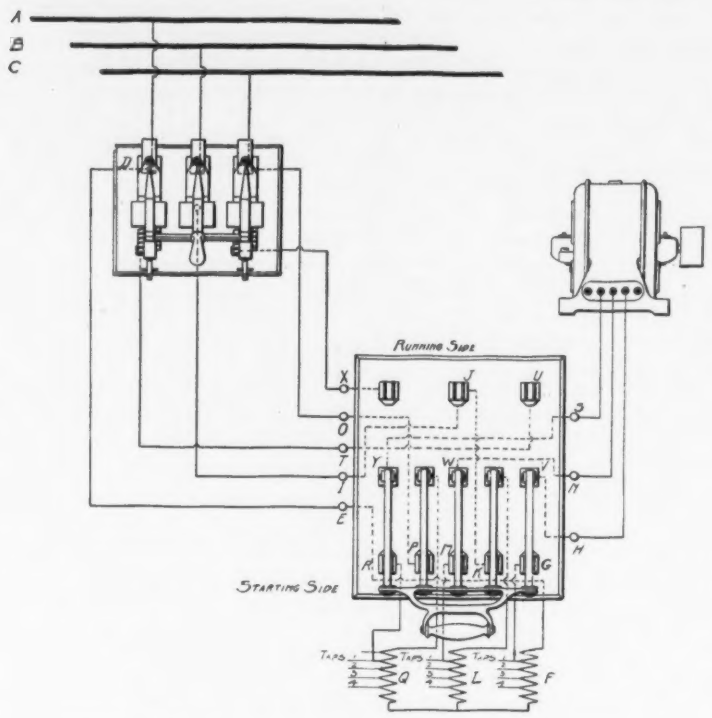
The Protection of Polyphase Motors.

A new type of I-T-E circuit breaker has been designed by the Cutter Company for use in connection with polyphase motors. Polyphase motors are, for the most part, so admirably built, and their ability to withstand heavy overloads is so well known, as to very frequently lead to their being carelessly started and otherwise unduly abused. While this may not result in immediate injury to the motor, it causes excessive disturbance in the voltage of the circuit, undue waste of energy, and may result, sooner or later, in serious injury to the machinery operated by the motor—always an item of much greater cost than that of the motor itself.

The heavy starting current required by many types of polyphase motors has heretofore constituted a serious objection to the use of "Overload" circuit breakers for their protection. This difficulty is overcome by making the connections as shown in the accompanying diagram between the auto-converter and the circuit breaker, so that the latter will be included in the circuit of the motor only when the switch of the auto-converter is in the running position. When the circuit-breaker is connected in this manner, it will not be acted upon by the currents which pass while the switch is in the starting position; but should the switch be thrown into the running position at once, or before the motor has come up to speed, the circuit breaker will open upon the resulting overload, as it also will in case the motor is unduly loaded.

Another source of danger to polyphase motors is the accidental

severance of but one phase of the circuit, due, in most cases, to the blowing of an irresponsible fuse, either at the motor or somewhere in the circuit supplying it. Where this occurs when the motor is running, the latter will, unless very lightly loaded, come to a standstill, and if not promptly disconnected is liable to injury. With this

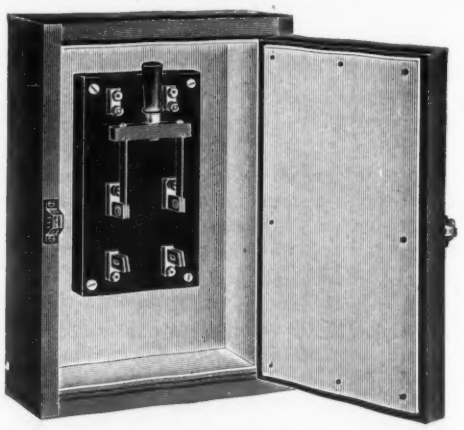


CONNECTIONS OF CIRCUIT-BREAKER FOR POLYPHASE MOTORS.

point in mind, the insuffiency of fuse protection for polyphase motors at once becomes obvious, and the necessity is plainly seen for a device which insures the opening of all phases simultaneously when the circuit of any one phase is interrupted.

Cabinet Work for Electrical Purposes.

E. J. Noblett & Co., of Chicago, are catering to the electrical trade in the matter of cable terminal boxes, service switch boxes, cross arms, pins and brackets; in fact, all kinds of high-grade woodwork. This concern makes nothing but the box part of the cable and service boxes, the contents of the box being left to the choice of the user. It furnishes the highest grade of work on these classes of boxes. It already numbers among its customers some of the largest electric lighting and telephone companies. Its boxes for containing electric



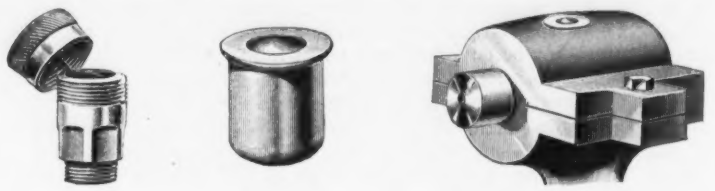
SERVICE SWITCH BOX.

light service switches and fuses are asbestos-lined, made according to underwriters' specifications and approved by them. Cable terminal boxes are made of 1⅛-in. finished lumber, all joints tongued, grooved and white-leaded. They are painted with two coats of asbestos paint inside and two coats of white lead outside.

As power transmission at high voltage has recently become an important part of electrical industry, this company is now prepared to turn out pins for high-voltage insulators of as great length as any electrical engineer will care to specify, automatic machinery having been introduced to produce pins up to 30 in. in length. Many of the larger central station and transmission companies will no doubt be glad to know of a wood-working establishment which makes a specialty of this class of work and sells direct to the consuming companies.

Oil Cups and Oil Hole Covers.

The accompanying illustrations represent the Bennett toggled-top oil cup and the Bennett self-closing oil-hole cover, which are manufactured by the Bay State Stamping Company, Worcester, Mass. The oil cup cover, when unscrewed, lies at one side, as shown, thus giving plenty of room for the insertion of the spout of the oil can. The cover, therefore, cannot be lost, and when it is screwed



FIGS. 1, 2 AND 3.—OIL CUP AND OIL HOLE COVERS.

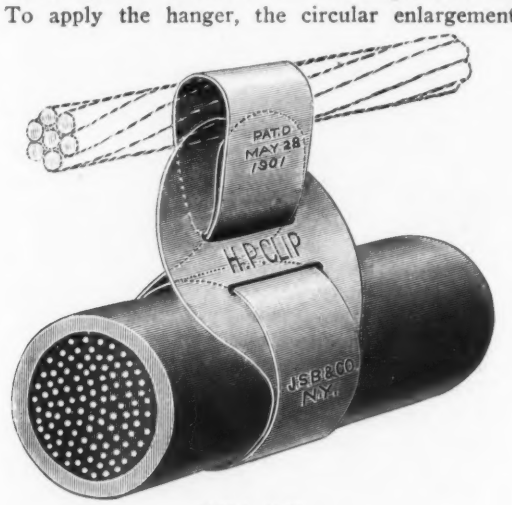
home the cup is rendered oil-tight. This cup is also made without thread and packing in the cover for use on common bearings where an oil-tight cup is not necessary.

The self-closing oil-hole cover can be applied by drilling the oil hole a proper size and forcing the oiler in. The oil is inserted by pressing the oil can spout upon a valve which closes by a spring when the can is removed. The cover projects a trifle above the surface, thus rendering it convenient to keep clean. It is made in three pieces, a case valve and spring, the valve being made with projecting arms to guide it centrally and allow the oil to pass. The advatages claimed for this cover are economy in cost and application, convenience and neatness in using, while by reason of its simplicity of construction there is nothing to get out of order.

Fig. 1 shows the oil cup; Fig. 2, the oil hole cover, and Fig. 3 a cover in place on a bearing.

A New Cable Clip.

The "H-P" cable clip, which is now being manufactured by Messrs. James S. Barron & Co., of 200-206 West Broadway, New York, is made of one piece of zinc and is, therefore, rustless and has no parts to become detached and lost. It is a simple device and easily put on. To apply the hanger, the circular enlargement is held



CABLE CLIP.

against the cable with the left hand while the free end is wound around and passed through the slot. It is then wound around again, put through the upper slot and carried over the suspension wire, after which it is bent and hooked into the upper slot.

The cut shows the hanger gripping the cable. These hangers are made in all lengths from 10½ in. up, the widths being the same in all lengths.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Time money was offered with comparative freedom and there was a fair demand. The closing rates were 5¼ @5½% for 30 to 60 days; 5@5½ for three, four, five and six months. The stock market was irregular and showed a somewhat firmer tone than was indicated in the report of the previous week. Little or no public buying was, however, aroused by the tendency of the prices to improve in the early part of the week. A severe drive was made at Western Union on Wednesday, based on allegations that effective competition from the wireless telegraph organization may be expected in a short time. The industrials were on the whole relatively steady. The United States Steel shares were rather neglected, and the very favorable accounts about current earnings had little effect on account of the indisposition which is shown to trade in the securities on an active scale. Brooklyn Rapid Transit was rather steady early in the week and developed decided strength on Friday. Indeed, this was the only stock in the traction and electrical lists that showed a gain at the end of the week. It dropped to 64½, but rallied and closed at 67½, this being a net gain of 2¼ points. Metropolitan Street Railway showed considerable weakness and closed at very near the lowest point of the week, the last quotation being 133⅜. At no time did it go beyond 136⅜. The closing figure represents a loss of 1⅜ points. In the electric list both General Electric and Westinghouse showed marked declines, the former losing 4¼ points and the latter 11 points. General Electric closed at 186, being 2 points above the lowest figure of the week and 3½ under the highest. Westinghouse closed at the lowest point—196. As the result of the attacks upon Western Union that stock reached the low level of 84, but at the close had gained 1 point, representing a net loss of 2⅜. American Telegraph & Telephone closed at the lowest figure of the week—81¼, being a loss of ¾ of a point. In Boston values were lower and the market conditions somewhat unsettled. Copper shares showed weakness in sympathy with like conditions in New York, although it did not cause a great deal of liquidation. Following are the closing quotations at New York, of April 7.

NEW YORK.

	Mar. 31.	Apr. 7		Mar. 31.	Apr. 7
American Tel. & Cable	81	81¼	General Electric	188	185
American Tel. & Tel.	†159	155	Hudson River Tel.	..	..
American Dist. Tel.	32	..	Metropolitan St. Ry.	135¾	133⅜
Brooklyn Rapid Transit	66	67¾	N. E. Elec. Veh. Trns.	⅛	..
Commercial Cable	..	..	N. Y. & N. J. Tel.	165	..
Electric Boat	23	23	N. Y. E. V. T. Co.	8¾	..
Electric Boat pfd.	37	37	Tel. & Tel. Co. Am	..	..
Electric Lead Reduction	1⅛	1⅛	Western Union Tel.	87⅝	85⅛
Electric Vehicle	8⅝	12¼	Westinghouse com.	198	194½
Electric Vehicle pfd.	13	16	Westinghouse pfd.	198	194

BOSTON.

	Mar. 31.	Apr. 7		Mar. 31.	Apr. 7
American Tel. & Tel.	158½	154	Western Tel. & Tel. pfd.	97⅛	97*
Cumberland Telephone	..	..	Mexican Telephone	2⅛	2
Edison Elec. Illum.	..	265	New England Telephone	139*	135
General Electric	189¼	186	Westinghouse	100	98
Western Tel. & Tel.	21	20	Westinghouse pfd.	100	98

PHILADELPHIA.

	Mar. 31.	Apr 7		Mar. 31.	Apr. 7
American Railways	50¼	..	Phila. Traction	97	97¼
Elec. Storage Battery	77†	77*	Phila. Electric	6¾	7
Elec. Storage Battery pfd.	..	77*	Pa. Electric Vehicle	..	..
Elec. Co. of America	9	8⅜	Pa. Electric Vehicle pfd	..	..

CHICAGO.

	Mar. 31.	Apr. 7‡		Mar. 31.	Apr. 7‡
Central Union Tel.	..	..	National Carbon pfd.	98½	..
Chicago Edison	..	..	Northwest Elev. com.	..	..
Chicago City Ry.	212	..	Union Traction	9	..
Chicago Tel. Co.	..	..	Union Traction pfd.	..	..
National Carbon	24⅝	..			

*Asked. †Ex Dividend. ‡Election.

NEW YORK TRANSPORTATION.—At the annual meeting of the New York Transportation Co. the following directors were elected: Henry Sanderson, G. H. Day, G. Herbert Condict, G. W. Wesley, W. H. Palmer, Jr., Harry Payne Whitney, Philip T. Dodge, Wm. K. Ryan, Frank T. Strachan. Messrs. Day and Dodge succeed H. L. Zabriski and James E. Hayes. Some stockholders present showed considerable dissatisfaction because the company issued no financial statement and an effort was made to lay the motion to proceed with the election of directors, on the table, but it was lost upon a stock vote. President Sanderson said that the electric automobile business during the current year showed a substantial growth and the earnings are showing a satisfactory increase, the profits during the winter months being very gratifying. After the annual meeting the minority stockholders met and adopted the following resolutions: "As stockholders of the New York Transportation Co., representing several thousand shares of its stock, we enter our earnest protest against the conduct of the annual meeting of the stockholders and the refusal of the president of the company, Henry Sanderson, to permit the free discussion of motions or to enter reasonable inquiries of the stockholders to permit them to examine the by-laws of the company, or to give them any information in regard to the conduct or conditions. We denounce the manner in which the stockholders were refused a hearing and in which they were overridden by the authority of the chair and by the stifling of debate."

NEW JERSEY LIGHT AND TRACTION DEAL.—Reports from Newark, N. J., are to the effect that negotiations are pending for the formation of a large holding company to take over all the North Jersey trolley companies, together with the New Jersey electric light and gas companies. The Prudential Insurance Company, of Newark, the Equitable Life Assurance Society, of New York, the United Gas and Improvement Company, of Philadelphia, are said to be allied with the Fidelity Trust Company, of Newark, which concern has for some time been negotiating for the control of the trolley lines. If the deal becomes a reality, the merger will include the following companies: North Jersey Street Railway Company, capital, $15,000,000; Jersey City, Hoboken and Paterson Railway Company, capital $20,000,000; Orange and Passaic Valley Street Railway Company, capital $1,000,000; Gas and Electric Company, of Bergen County, authorized capital, $2,000,000; Paterson and Passaic Gas and Electric Company, authorized capital, $5,000,000; Essex and Hudson Gas Company, capital, $6,500,000; Hudson County Gas Company, capital, $10,500,000; Gas Light Company of New Brunswick, capital, $400,000 stock, $500,000 bonds; Central Electric Company, capital, $750,000 bonds, $750,000 stock; Shore Electric Company, capital, $76,000; Consolidated Gas Company of New Jersey, capital, $1,000,000, bonds, $971,000; United Electric Company of New Jersey, Capital, $20,000,000, bonds, $16,239,500. This corporation takes in twenty-one corporations doing business in Essex, Hudson, Bergen, Union and Morris Counties. South Jersey Gas, Electric and Traction Company, capital, $6,000,000, bonds, $6,000,000; Elizabeth, Plainfield and Central New Jersey Railway Company, capital, $3,000,000, bonds, $1,500,000.

MARCONI FINANCES.—The annual meeting of the Marconi Wireless Telegraph Company of America will be held April 20 at 15 Exchange Place, Jersey City. No stock can be voted on which has been transferred within 20 days next preceding this election. The balance sheet as of January 31 is as follows:

Assets:	
Patent rights	$5,286,494
Cost of stations and experimental work	139,939
Stock of apparatus on hand	31,244
Accounts receivable	18,382
Cash at bank and in hand	15,432
Furniture and fixtures	1,204
Treasury stock	700,000
Organization expenses	35,468
Total	$6,228,166
Liabilities:	
Capital stock issued	$6,190,000
Accounts payable	38,166
Total	$6,228,166

About May 1 Mr. Marconi will return to America and an attempt will be made to establish constant and uninterrupted communication between this country and England. On the same date, May 1, the Porto Rican government will open proposals for a wireless service in Porto Rico. The Marconi Company expects that it will secure the contract for this service.

STANLEY ELECTRIC.—The new officers of the Stanley Electric Mfg. Company, of Pittsfield, Mass., elected at the recent meeting of the board of directors are as follows: President, W. Murray Crane, Pittsfield, Mass. 1st vice-president, Dr. F. A. C. Perrine, Pittsfield, Mass. 2nd vice-president, M. D. Barr, New York, N. Y. 3d vice-president, S. N. Hamill, New York, N. Y. Treasurer, W. W. Gamwell, Pittsfield, Mass. asst. treasurer, R. S. Murray, Pittsfield, Mass. secretary, W. S. Westover, New York, N. Y.; asst. secretary, A. G. Davis, New York, N. Y.

CURTIS TURBINE CO.—According to Wall Street authorities, the General Electric Co. will organize a company to take over the Curtis turbine, but there will be no rights for stockholders in connection with the matter. Mr. C. Curtis, the inventor, will probably be given a 4% preferred stock issue of $1,000,000 for his patents, and his services will be retained by the company. All the common stock will be held by the General Electric Co.

WESTERN UNION WEAKNESS is without much apparent explanation, except the doubt whether the business can yield profit enough to cover repairs and reconstruction without calling for new capital. Just now a good deal of the system is being renovated. Wireless competition does not yet cut much figure. The rumor that financial backing has been secured for a new company to erect poles and wires and enter into active competition with Western Union and Postal Telegraph between New York and Chicago is discredited by officials of both the Western Union and Postal Telegraph Companies.

CENTRAL UNION TELEPHONE.—Advices from Chicago state that the directors of the Chicago and the Central Union Telephone Cos. have decided upon the successor to Mr. John I. Sabin, formerly president of both companies and will announce the names in a short time. It is understood that each company has chosen a separate president as it is believed that the companies can be better managed with a distinctive head officer over each. The Central Union stock is very dull, notwithstanding that the capital stock was recently cut in half. At that time it had a market value of $40 per share, and after the reduction there were a few scattering sales at 75 and 80. The stockholders refused to take much of the new treasury stock at par, the American Telephone & Telegraph Co. being the main subscriber. The promises of a 5% dividend were not fulfilled and the question of future financeering of the company is quite problematical. As already announced in these columns Mr. Sabin has returned to the Pacific coast and will give his exclusive attention to the management of the Pacific coast Bell telephone companies in which he has a large personal interest.

Commercial Intelligence.

THE WEEK IN TRADE.—The industries, particularly in iron, steel and lumber, are active all over the country. The Spring crop of strikes is equal to the average, though most of them have appeared a trifle earlier, particularly in the building trades. The activity in lumber is a notable feature just now, the only complaint being that deliveries are not sufficient to meet current demand. Retail trade is expanding, favored by spring-like weather; and jobbers report reorders from retailers increasing while collections show some improvement. Southern trade advices are better. In the central West the demand from jobbers has improved, notably at Chicago and St. Louis. Better rates have helped retailers and collections show some improvement. Pressure of foreign iron at the Eastern seaboard market is the reason assigned for the cut of $1 per ton in Southern foundry grades and for the sympathetic weakening of 50c. per ton for other kinds of pig iron at Eastern markets. A large business is reported at the concessions, however. In finished iron, only favorable reports are noted. Transportation has improved. Coke is in better supply, iron furnaces and mills being better able than ever to supply current demand, and quotations continue firm. The business failures for the week ending April 2, according to the Bradstreet compilation, numbered 145 against 175 the week previous, and 176 in the corresponding week of last year. *Bradstreet's* reports of failures show the smallest number of embarrassments in the first quarter for twenty years past, and the smallest number of liabilities in sixteen years. Export trade continues excellent, particularly in cotton and corn and the fiscal year's total will probably equal the best previously recorded, taking exports as a whole. Gross railway earnings returns to date indicate a gain of 14% for March over the same month last year, and are by that percentage the best ever recorded for that month. The copper market was very quiet and consumers are well supplied for the near future. On the other hand, sellers, it is stated, have very little copper for sale for the present and little for delivery during the next few months. March exports are figured by the Metal Exchange at 12,840 gross tons as compared with 20,012 gross tons during the same period last year. The total exports for the first quarter are 32,254 tons and 49,490 tons, respectively, a decline of 17,236 gross tons.

POWER HOUSE AND RAILWAY EQUIPMENT FOR YOKOHAMA.—The Yokohama Electric Tramway Company, which is to build a six-mile road from Yokohama to Kanagawa, has placed a contract for power house apparatus and railway equipments with the Japanese house of Takata & Co. The contract calls for two Westinghouse 150-kw, 500-550-volt, direct-current engine-type generators with a standard Westinghouse railway switchboard, also 22 Westinghouse double-motors, 25-hp, arranged for electric braking. The equipments are to be arranged for a double-trolley system. The Takata contract also calls for 22 Brill trucks. Takata & Co. are also to furnish two 10-in. Blake automatic relief valves. The International Steam Pump concern will also ship two Knowles feed pumps and receivers to be used in feeding the water condensation from the steam pipes and steam jackets of the engines direct to Babcock & Wilcox boilers. Two 5-in. Cochrane steam separators supplied through F. E. Idell, 26 Cortlandt Street, and two 30 (nominal)-hp patent vertical feed water heaters made by the Wheeler Condenser & Engineering Company, 120 Liberty Street, New York, have also been specified. The car bodies will be built in Japan. The equipment will be shipped during June and July. The Yokohama system will be entirely arranged for double trolley, this method being required by the Japanese officials in the large cities especially, ground return being prohibited.

EQUIPMENT FOR BIG CANAL DOVER (OHIO) LOCOMOTIVE PLANT.—The Standard Motive Power Company, Consolidated Exchange Building, 60 Broadway, has just determined on the letting of an important contract for the construction and equipment of its plant, to be built at Canal Dover, Ohio. The Pittsburg (Pa.) Engineering Company have secured the contract. The plant proposes to manufacture locomotives, transform existing locomotives, construct street and interurban motor cars and build automobiles under the Dodge system. In the completion of the first sections it will mean an estimated expenditure of $1,000,000. Electrical equipment will be utilized very extensively in the building of the locomotives, etc. The Whiting Foundry & Machine Company, of Harvey, Ill., New York offices, Taylor Building, 39-41 Cortlandt Street, will build the electric traveling cranes.

ENGINES FOR YOKOHAMA TRACTION PLANT.—McIntosh, Seymour & Co., Havemeyer Building, 26 Cortlandt Street, have been awarded the contract for the engines to be installed in the power station of the Yokohama Electric Tramway Company. There will be two center-crank, horizontal-tandem compound-condensing piston valve, operating at 200 r.p.m., direct-connected to Westinghouse generators. The rated load of these engines is 230 indicated hp for each machine. The steam pressure will be 125 pounds. The engine contract was secured by the American Trading Company, New York, which purchases considerable electrical equipment, etc., for the Far East.

MEXICAN ELECTRIC RAILWAY PROJECT.—The construction of an electric railway is projected between a point near Cordoba, on the Vera Cruz & Pacific Railroad, and Tierra Blanca, on the same Mexican road. The line will be about 75 miles in length. Andrew Mackenzie, president of the San Rafael & Xico Railway, is interested in the project. He is now in Canada making arrangements for the construction of the system. Power is to be derived from a hydraulic plant on the Rio Blanco. The concession for the water power was recently secured by a company in which F. P. Hoeck, of F. P. Hoeck & Co., 1a San Francisco No. 12, Mexico City, is the head.

EQUIPMENT FOR UNITED STATES FORTIFICATIONS.—The United States Corps of Engineers, at Fort McKinley, Portland, Me., have requisitioned for the installation of three 130-hp Westinghouse cross-compound engines, to be direct-connected to General Electric generators. The equipment will be utilized for general power and lighting purposes. A similar installation will be made at Fort Levett, Portland, Me.

GENERAL ELECTRIC ARC LIGHTING SYSTEM FOR CHINA.—The commission house of Fearon, Daniel & Co., of China, 90-96 Wall Street, has awarded a contract to the General Electric Company for a complete arc lighting system at Shanghai. The contract requisitions for 160 series inclosed arc lamps, two 50-light transformers, the same number of 25-light transformers, four switchboards, etc.

MEXICAN WATER POWER SCHEME.—W. W. Graham, Rafael Gonzalez Platt and Manuel Macotela, all of Mexico City, are after a franchise for the purpose of utilizing the waters of the River Grande in the district of Temascaltepec, State of Mexico, to generate electricity. In the application made to the Mexican authorities it is proposed to use 10,000 litres per second.

NEW PERUVIAN LIGHTING PLANT.—An electric lighting plant is to be constructed at Piedra Leco, Peru. The order for the engine has been taken by J. K. Robinson, of Iquique, acting on behalf of Westinghouse, Church, Kerr & Co. It will be of 460-hp capacity, compound-condensing and of direct-connected type.

GENERAL SUPPLIES FOR JAPAN.—Francis A. Cundill, 90-96 Wall Street, New York, who represents the interests of the British electrical engineering and contracting firm of J. F. Healing & Co., Yokohama, has just secured a substantial contract for general electrical supplies.

TELEPHONE WIRE FOR JAPAN.—The Hazard Manufacturing Company, of 50 Dey Street, New York, has secured a contract for telephone wire for shipment to Japan. The contract came through Francis A. Cundill, 90-96 Wall Street.

ROYAL ELECTRIC CO., of Peoria, Ill., has just received from the Black Hills Electric Light Co., of Deadwood, S. D., a third order for alternating current generators.

GROWTH OF EXPORTS.—The growth in the exportation of manufactures from the United States and their distribution to countries and grand divisions are discussed in much detail in a monograph prepared by the Treasury Bureau of Statistics, for publication in the April Summary of Commerce & Finance. It shows the exportations of manufactures in each year from 1790 to the present time and their distribution country by country, and article by article in each year from 1892 to 1902. The exportation of manufactures has grown from $1,243,547 in 1790 to $17,580,456 in 1850, $102,856,015 in 1880, $151,102,376 in 1890, and $403,641,401 in 1902. In 1790, manufactures formed 6.15% of the total domestic exports; in 1850 13.03%; in 1880, 12.48%; in 1890, 17.87%, and in 1902, 29.77%. This shows that the exports of manufactures are increasing much more rapidly than those of other great classes of the exports. This growth in the exportation of manufactures is especially marked in the period since 1895. In that year, 1895, the total exports of manufactures were $183,595,743, having gained 81 million dollars in the 15 years between 1880 and 1895. In the 8 years from 1895 to 1903 the increase was 220 millions. Thus in the 8 years since 1895, the increase in the exportation of manufactures has been nearly three times as much as in the 15 years immediately prior to 1895. The statements of distribution of the manufactures exported also show some striking and interesting facts. They show, for example, that practically one-half of the manufactures exported from the United States go to Europe, and that the exportation of manufactures to Europe has grown from 76 millions in 1892 to 197 million dollars in 1902. To North America other than the United States, our exports of manufactures have grown from 33 millions in 1892 to 100 millions in 1902.

WESTINGHOUSE FOREIGN CONTRACTS.—The Westinghouse interests have secured within the past few days several fair-sized contracts for engines, both steam and gas, generators and other equipment to be installed in Mexican, South American and Australian plants. Among the Mexican contracts in hand is one for a 300-hp compound engine for direct-connection to an alternating-current generator ordered through G. & O. Braniff, Mexico City, on behalf of the Negociacion Minera Promontorio. The Braniff people have also sent in an order for five small engines for shipment to Salina Cruz in connection with the harbor construction work now being undertaken at that Mexican port by the British contracting firm of S. Pearson & Son, Limited, which is building the National Tehuantepec Railway. The Montezuma Lead Company, another Mexican concern, has ordered two 100-hp Westinghouse compound engines for belting to generators. One generator is already installed and the other will be built by the C. & C. Electric Company, 143 Liberty Street. T. F. Witherbee, superintendent of extensive iron mines at Durango, has ordered a small Westinghouse compound engine to be belted to a generator for lighting purposes. J. K. Robinson, of Iquique, who represents the Westinghouse interests on the west coast of South America, has sent in orders for several small engines to be belted to generators for general power work. The Australian electrical engineering and contracting firm of Noyes Brothers, Sydney and Melbourne, has ordered a 200-hp compound engine to be direct-connected to an alternating-current generator.

THE LOMBARD WATER WHEEL GOVERNOR COMPANY, of Boston, reports that the demand is good for its high-grade water wheel governors. It has recently closed orders for different types with the Cascade Electric Co., of Berlin, for 1 governor; Redlands Elec. Light & Power Co., of California, 1 governor; Brattleboro Gas Light Company, Brattleboro, Vt., 1 governor; Ware Shoals Mfg. Co., Laurens, S. C., 2 governors and 4 hydraulically balanced relief valves; Nasonville Woolen Co., Nasonville, R. I., 1 governor; Athens Elec. Rwy Co., Athens, Ga., 1 governor; Ludlow Mfg. Associates, Ludlow, Mass., 1 governor; Sebasticook Power Co., Sebasticook, Me., 3 governors; Niagara Falls Power Co., Niagara Falls, N. Y., 1 governor; Lynchburg Water Power Co., Lynchburg, Va., 4 governors and 4 electric speed controllers; Public Works Co., Bangor, Me., 2 governors with electric speed controllers; Zanesville Electric Lt. & Pr. Co., Zanesville, O., 2 governors with electric speed controllers; Canadian Elec. Lt. Co., Levis, Que., 1 governor; Victor M. Braschi & Bro., City of Mexico, 1 governor; Sacramento Electric, Gas & Rwy. Co., 1 governor and electric speed controller; Valley Counties Power Co., of California, 2 governors with electric speed controllers. Also some governors ordered through dealers for destinations unknown.

THE MACKAY ENGINEERING COMPANY report that they have closed the contract for a large equipment for Conron Brothers, provision dealers, Fourteenth Street and Tenth Avenue, New York. The outfit includes one 100-kw and one 75-kw Akron generator, each direct-connected to a Reeves vertical compound engine, two 1,000-hp boiler feed pumps, two 200-ton brine pumps and one 600-gallon deep well pump, as well as a number of motors for driving air compressors. They also report a large demand for the National underwriter fire pumps, for which they are eastern agents. The company are just installing two 150-kw Akron generators, direct-connected to a 500-hp cross-compound Williams vertical engine in the Navy Yard, New York.

THE STROMBERG-CARLSON TELEPHONE MFG. CO. has recently sold switchboards to the following companies: Rossville Home Tel. Co., Rossville, Ind.; West Va. Western Tel. Co., Parkersburg, W. Va.; Winchester Tel. Co., Winchester, Ind.; S. S. Hooks, Gilmore, Ill.; J. W. Corwin, Dahlgren, Ill.; Newport Tel. Co., Newport, Tenn.; E. P. Phillips, Lakenan, Mo.; Zenith City Tel. Co., Duluth, Minn.; O. I. Miller, Woodburn, Oregon. It has also recently sold telephones and material to the Farmers' Telephone Co., at Windsor, Ill., Green Valley Tel. Co., Green Valley, Ill., and the London Mills Tel. Co., London Mills, Ill. The factory is now turning out 1,200 telephones a day.

SOME WESTINGHOUSE GAS ENGINE ORDERS.—The Franklin Electric Company, Franklin, Pa., has placed a contract with Westinghouse, Church, Kerr & Co. for five gas engines, to be operated on natural gas belted to generators of 125-hp each, for lighting work. Two Westinghouse gas engines of similar capacity, and to be operated on natural gas and for lighting use, have also been ordered for the plant of the Indianapolis Water Company, of Indianapolis, Ind. These engines will be direct-connected to 80-kw, 250-volt Westinghouse generators. A switchboard has also been requisitioned.

BIDS INVITED.—The Department of Education of the Borough of Manhattan, New York City, is inviting bids on April 13 for wiring and installing electric light and electric bell fixtures in a new public school building in the Borough of the Bronx; also for installing a central-energy telephone system in the Morris High School in the Borough of the Bronx. Bids are also called for for a telephone system in the new High School of Commerce on 65th Street and Amsterdam Ave., Manhattan. Mr. C. B. J. Snyder is Superintendent of School Buildings.

WORTHINGTON PUMP ABROAD.—A cable dispatch from London of April 6 says: Samuel Untermyer, of New York, will tomorrow incorporate the Worthington Pump Company, Limited, with a capital of $4,500,000, consisting of $2,000,000 in 5 per cent. bonds and $2,500,000 in shares. The company acquires the European business of the Worthington and Blake Companies, in addition to others. Two factories will be erected, one in Germany and the other in Russia. The directorate will be jointly American and English.

EXTENSION OF JAMESTOWN (N. Y.) STREET RAILWAY.—The Jamestown (N. Y.) Street Railway Company is to extend its plant and is now letting contracts for considerable equipment through its president, Mr. W. Brodhead. The Westinghouse interests have secured the contract for the engines and generators. There will be three cross-compound condensing engines of 460-hp capacity each. They will be direct-connected to alternating-current generators of 250-kw each.

BALL ENGINE ORDERS.—The Central Connellsville Coke Co., New Salem, Fayette Co., Pa., is installing an electric plant. The engine will be furnished by the Ball Engine Co., Erie, Pa. The Excelsior Springs Elec. Light Co., which is building a new plant at Excelsior Springs, Mo., has purchased two 135-hp tandem compound engines from the Ball Engine Co. The engines will be direct connected to General Electric generators.

GAS ENGINES FOR GREECE.—Westinghouse, Church, Kerr & Co. have just been allotted an order for gas engines by D. P. Zacharias, of Athens, for installation in an electric lighting plant in the Grecian capital. There will be two Westinghouse gas engines, of 63-hp each, 3-cylinder producer gas type, belted to generators. The engines will be operated under the system of D. R. Wood & Co., of Philadelphia, Pa.

THE STANLEY ELECTRIC MFG. COMPANY has sold to the Indianapolis, Columbus and Southern Railway Company the following apparatus; Forty-eight railway motors, one 500-kw revolving field generator, one 300-kw rotary converter, three 110-kw and three 150-kw transformers, and the necessary switchboard apparatus.

WELLMAN-SEAVER-MORGAN.—News comes from Cleveland of the merger of the Wellman-Seaver-Morgan Engineering Company, of Cleveland, and the Webster-Camp & Lane Company, of Akron, under the name of the Wellman-Seaver-Morgan Company, and with a combined capital of $3,000,000.

WIRE OUTPUT.—An official of the American Steel and Wire Company is quoted as saying that the output of the mills for the quarter ended with March was by far the largest ever known, exceeding the corresponding period last year by fully 20 per cent.

IRON CITY ENG. CO., of Pittsburg, Pa., has been awarded the contract for the entire electrical work to be installed in the Stoneleigh Court, Washington, D. C.

General News.

THE TELEPHONE.

AZUSA, CAL.—Application has been made to the local Board of Trustees by the Home Telephone Company, of Covina, for a telephone franchise in this city.

LOS ANGELES, CAL.—The Long Beach Telegraph & Telephone Company has incorporated, with a capital stock of $50,000, of which amount $10,000 has been subscribed. The directors are Charles L. Zahn, W. M. Eason, J. C. Brainard, W. L. Porterville and Don C. Porter.

RICO, COL.—The Colorado Telephone Company has asked for a franchise in this city.

DERBY, CONN.—Eight girls employed in the Southern New England telephone exchange in this city struck, on March 30, because the management, thinking that seven hours was too long for them to work without having an hour in which to rest, decided to change the working time into two shifts of four hours each, paying them for the extra hour. The girls preferred to work seven hours straight without a rest and when the management insisted on having its way they quit.

ATLANTA, GA.—The Atlanta Telephone and Telegraph Company has been incorporated at Wilmington, Del., to construct telegraph and telephone lines in Atlanta, Ga.; capital, $400,000.

AUGUSTA, ILL.—The Augusta Mutual Telephone Company has organized with George Catlin as president.

STRAWN, ILL.—The Strawn Telephone Company has been incorporated with a capital stock of $1,500 by Reis C. Gullberg, Joseph Duntz and J. W. Kirkham.

PEORIA, ILL.—The Northern Middlebrook Telephone Company, with a capital stock of $600, has been incorporated and will build a line from Laura to Princeville.

GREENFIELD, IND.—The Shady Grove Telephone Company has incorporated to establish an exchange in the Shady Grove School house and extend lines throughout Hancock County. Jasper M. Burch, J. F. Stultz, W. H. Foster and W. W. Piles are directors.

NEW RICHMOND, IND.—The New Richmond Co-operative Telephone Company has incorporated to build an exchange in New Richmond and lines in Montgomery and Tippecanoe counties. The capital stock is $12,000. M. L. Claypool, O. W. Mason, Edgar Waltz and Wm. Graves are directors.

CRAWFORDSVILLE, IND.—The Crawfordsville Co-operative Telephone Company has decided to make an effort to get a complete trunk line system in Montgomery County. To this end a committee was appointed to confer with the co-operative companies elsewhere in the county, and if possible to make arrangements whereby all lines will merge and the county be supplied with a complete system.

ELKHART, IND.—The Home Telephone Company, which is putting in a 2,400-line multiple switchboard at a cost of $24,000, announced an advance of 25 cents per month in the rent of each telephone beginning April 1. It anticipated that at least one hundred subscribers would give notice of withdrawal of patronage, but only two have filed such notice. The company has nearly 900 subscribers and the new rate is $2.25 and $1.25 for business houses and residences respectively.

WABASH, IND.—The Home Telephone Company, of this city, has issued $15,000 worth of 5 per cent. bonds for the payment of floating indebtedness incurred in building extensions and in making improvements to the local plant and toll lines. The company will this Spring build a complete system of rural telephones in the country around Wabash. It has already 300 applications for telephones from farmers. Trunk lines will be run out on the principal roads, and party lines will be built therefrom to farm houses. In some of the prosperous small towns independent switchboards will be installed.

SHEFFIELD, IA.—At a recent special election a telephone franchise was granted to the People's Mutual Telephone Company, of Latimer. A new exchange will be established at once.

DES MOINES, IA.—The Stratford Telephone Company, of Hamilton County, has filed articles of incorporation, the capital stock being $1,500. Mr. Edward Peterson is president and Fred Reugnitz, secretary.

NEWPORT, KY.—The Fitzsimmons Telephone Manufacturing Company, of Cincinnati has applied for a franchise to install a telephone system in Newport.

BALTIMORE, MD.—The Peninsula Long-Distance Telephone Company has been incorporated in Maryland for the purpose of establishing an extensive telephone service in various counties on the Eastern Shore. The company will have a capital of $100,000. The main line is to be built from Elkton to Crisfield, Md., from Middletown to Dover, Del., and to Cape Charles City, Va. Branch lines will be constructed to take in all the principal points as far as Rehoboth, Del. The Peninsula Company's main line will connect with the Maryland telephone system at Elkton. The names of the incorporators are Stanley Baker, David E. Evans, Harry Welles Rush and Joshua Clayton.

GRAND RAPIDS, MICH.—The Citizen's Telephone Company, it is stated, will expend between $15,000 and $20,000 in extending its system.

LANSING, MICH.—The following-named independent telephone companies were incorporated recently: Henrietta Telephone Company, Henrietta, capital $5,000; Monroe County Telephone Company, Monroe, capital $15,000; Hillsdale Telephone Company, Pittsfield, $15,000.

AUSTIN, MINN.—The Interstate Telegraph & Telephone Company, which was recently incorporated here with a capital stock of $60,000, will be ready to begin operations about April 10. The affairs of the company will be conducted by a board of directors, as follows: James Keenan, John L. Gulden, Seymour Johnson, Thomas A. Revord and Charles A. Sterling.

MISSOULA, MONT.—The Bell Telephone Company will put in local exchanges at Lo Lo, Florence, Stevensville, Victor and Hamilton. These towns will connect with all the large fruit farms in the Bitter Root Valley.

CHOUTEAU, MONT.—The Montana Telephone Company, with headquarters here, has been organized to build telephone lines in Teton County. It is the intention of the company to absorb all small lines, besides building new ones.

BEAVER CROSSING, NEB.—The Beaver Crossing Telephone Company has been incorporated with a capital of $5,000. The incorporators are Dr. C. W. Doty, J. H. Ritche, Henry Gake and others.

LOVELOCK, NEV.—Dr. Asher, of this place, is interesting a number of citizens in a proposition to build a telephone line from here to a number of nearby towns.

BROOKFIELD, N. Y.—The Brookfield Telephone Company, of Brookfield, Madison County, has been incorporated; capital, $1,000. Directors: J. F. Keith, B. M. York and B. L. Spooner, of Brookfield.

MIDDLETOWN, N. Y.—The Orange County Telephone Company has decided to extend its system so as to connect with the Farmers' Telephone Company, of Sussex, N. J., the Highland Telephone Company and the Port Jervis Telephone Company, besides making other extensions.

NEW YORK, N. Y.—The New York and New Jersey Telephone Company is building a new telephone exchange on Grant Street, near Flatbush Avenue, Brooklyn, to relieve the congestion of telephone work in the eastern section of Brooklyn. The new building will be three stories high and will cost about $40,000.

BEAUFORT, N. C.—The Beaufort Telephone Company, capital $2,000, has been incorporated by N. W. Taylor and others.

GREENSBORO, N. C.—The Bell Telephone Company is soliciting subscriptions for a local system at Greensboro, which will probably precipitate a fight with the already existing company in this town.

HENDRUM, N. D.—The Hendrum Telephone Company, with a capital stock of $5,000, has been organized, Mr. V. H. Moffatt being president.

CARROLLTON, OHIO.—The Kilgore Telephone Company is building a line between Kilgore and Amsterdam.

HARPERSFIELD, OHIO.—The Harpersfield Telephone Company is installing a large number of rural telephones.

URBANA, OHIO.—The Urbana Telephone Company has secured a new site and is preparing to erect a new exchange building.

PORT CLINTON, OHIO.—The Port Clinton Telephone Company is laying a new cable across Portage River to Put-In-Bay Island.

DRESDEN, OHIO.—The Zanesville Telephone & Telegraph Company is extending its lines through Madison township and a large number of farmers' lines are being installed.

SMITHFIELD, OHIO.—The Farmers' Independent Telephone Company has been incorporated; capital $10,000. Incorporators: M. B. Cole, J. M. Copeland, A. H. Kreager, Frederick Scott.

JEWETT, OHIO.—The Connotton Valley Telephone Company, of this place, has been incorporated with a capital stock of $2,000. The names of the incorporators are G. O. Fleming, J. W. Harding, George H. Collins, R. H. Benedict, Isaac Stewart.

CINCINNATI, OHIO.—The Druggists' Association, of Cincinnati, is having a controversy with the City & Suburban Telegraph Association (Bell) relative to rates at pay stations in drug stores. The druggists demand 10 per cent. on $50 worth of business, 15 per cent. on $75, 20 per cent. on $100, 25 per cent. on $125, and to have free calls to wholesale houses. The terms proposed by the company are considerably lower and the druggists threaten to join hands with the projected independent company.

GUTHRIE, OKLA.—A territorial charter has been granted to the Oklahoma Southern Telephone Company, the capital stock being $15,000. The company will construct and operate a system in the counties of Cleveland and Pottawatomie and in the Creek, Seminole and Chickasaw nations. The incorporators are W. A. Jennings, Graham Brunham and R. C. Willard.

ABBEVILLE, S. C.—The Abbeville Telephone Company has recently entered into a sub-license agreement with the Southern Bell Telephone Company, the former agreeing to use only fixtures manufactured by the Bell Company.

WAKONDA, S. D.—The Wakonda Telephone Company has been formed to establish a local system.

CANTON, S. D.—The farmers throughout Lincoln County are enthusiastic over the telephone idea. They are organizing country exchanges and will build private lines connecting with city exchanges.

GREENVILLE, TENN.—A meeting of representatives of about forty independent telephones lines was held recently in Greenville to consider the matter of combining, a result which will probably be consummated.

DENTON, TEX.—The Independent Telephone Company has been granted a franchise by the council in this city.

PIEDMONT, W. VA.—The Piedmont & Keyser Telephone Company is making extensive improvements to its system and will extend its line from Barnum to Blaine and Elk Garden.

RONCEVERTE, W. VA.—A new telephone company has been formed here to build an independent line from this place to Elkins, connecting with the Virginia system at Barstow. S. W. Payne and E. N. Arbogast, of Marlington, are at the head of the enterprise.

GLEN-BROCKLY, WIS.—The West Wisconsin Telephone Company, with headquarters in this place, has been incorporated with a capital stock of $5,000, by D. H. Syme and C. J. Augustin.

MANITOWOC, WIS.—The Manitowoc & Western Telephone Company has elected officers as follows: President, Dr. R. S. O'Connell, of Cato; vice-president, J. E. Schultz, of Reedsville; secretary, J. P. Watt, of Maple Grove; treasurer, W. N. Killen, of Cato, and business manager, George Wittman, of Whitelaw. The company will make several extensions during the year.

ELECTRIC LIGHT AND POWER.

SAN FRANCISCO, CAL.—Local press reports state that the Mutual Electric Company will construct a new power plant on Folsom and Spear Sts.

LOS ANGELES, CAL.—The Independent Gas & Electric Company, of Los Angeles, has been incorporated, with a capital of $200,000. Incorporators: E. H. Durant and M. A. Newkirk, of Los Angeles.

WHITEWATER, COLO.—Haskell & Schwalbach, of Grand Junction, have prepared plans for a power dam to be constructed at Whitewater.

ATLANTA, GA.—The Westinghouse Electric & Mfg. Company is now making the machinery for the big power plant to be erected on the Chattahoochee River near Atlanta. Geo. Baum is consulting engineer.

ATLANTA, GA.—Local press reports state that two bids, one from J. F. Lester and the other from the Georgia Railway & Electric Company were received by Council March 23. Mr. Lester's bid provided for the construction of a $450,000 electric light plant. By yearly payments in fifteen years the city is to own this plant. The Georgia Railway & Electric Company agreed to furnish lights under contract as follows: 1 year arc lights at $110 each; incandescents $49.75; 3 years $82.50 and $33.75 and 7 years $79.50 and $21.75.

QUINCY, ILL.—The stockholders of the new Independent Light & Power Company have organized and elected a board of directors who met and elected officers as follows: J. W. Cassidy, president; Thomas D. Gardner, vice-president; C. E. Mead, secretary; J. J. Bragg, treasurer.

NOBLESVILLE, IND.—The City Council has granted a franchise to Thos. Griffin to construct an electric light plant.

GREENSBURG, IND.—A. R. Thompson & Co., of Chicago, Ill., contemplate constructing an electric light plant here.

SOUTH BEND, IND.—Electric power furnished by the St. Joseph river dam is now being used in this city, the connections having been established on March 26.

GREENSBURG, IND.—A. R. Thompson & Co., of Chicago, have applied for a franchise to construct and operate an electric light, heat and power plant in this city. It is thought the franchise will be granted.

WASHINGTON, IND.—The municipal electric lighting plant of this city is regarded as a financial success. The report of the trustees for the past year shows that the receipts were $91,640.43 and the expenses, bonds and interest, were $61,395.43, leaving a net profit to the city of $30,245, which is claimed to be ten per cent. on the $100,000 investment.

ELKHART, IND.—A franchise for the privilege of selling electric light and power in this city has been granted to the National Manufacturing Company. The company will erect a big power plant at Bristol, ten miles above, on the St. Joseph river, where a good water dam and power will be constructed. Power and light will be furnished other cities in northern Indiana and Michigan.

INDIANAPOLIS, IND.—The ten-year contract to be let for lighting this city is attracting many inquirers. It is reported that an Eastern syndicate, some of whom are interested in the local gas plant, will bid on the contract with a view of building a new electric lighting plant here. A five-year contract was made a few days ago with the Indianapolis Light & Power Company to furnish light and power to run the pumps, the cascades and the elevator in the soldiers' monument at $5,000 a year, also a contract with the Jenney Electric Company to furnish two 60-hp motors at $1,730.

NOBLESVILLE, IND.—The City Council has granted to Thomas Griffin a franchise to put in an electric plant here. Mr. Griffin proposes to locate his power plant four miles north on White river and construct a sixteen-foot dam to furnish 1800 horse-power required. The local company now furnishing lights has asked the council for an increase in the price of lights from $70 to $85 a year, stating that unless granted the lighting will be discontinued as the plant is being operated at a loss of $600 to $700 per month. The city will enjoin the company from leaving the city in darkness before the Griffin plant is completed.

CALEDONIA, IA.—The citizens have voted to construct an electric light plant to cost about $8,000.

CLINTON, LA.—The Town Council has granted the Clinton Electric Light & Ice Company a franchise to establish an electric light and ice plant.

MADISON, ME.—A committee has been appointed to investigate the question of constructing an electric light plant. T. F. Manter is city clerk.

RIVER ROUGE, MICH.—The Council has appointed a committee to investigate the question of constructing an electric light plant.

BUHL, MINN.—The citizens have voted to construct an electric light plant.

FAIRFAX, MINN.—The citizens have voted to issue $20,000 bonds for an electric light plant and city hall.

MANKATO, MINN.—On March 20 the Court issued an order restraining the city from selling $40,000 bonds for pumping station and lighting plant. The order is made returnable on April 6.

WINONA, MINN.—The Winona Railway & Light Co. has decided to expend about $100,000 in improvements, which will include the rebuilding of the present lighting and power plant.

VICKSBURG, MISS.—The Vicksburg Sanitarium will install a small electric light and heating plant. H. M. Street, of Vicksburg, is interested.

JACKSON, MISS.—The directors of the Jackson Light Company will soon let contracts for the construction of its plant. This company was recently incorporated with a capital of $25,000.

YAZOO CITY, MISS.—The Supreme Court has reversed the decision of Chancellor Conn in the injunction suit which restrained this city from issuing $75,000 bonds for constructing water works, an electric light plant and a sewerage system. This means the construction of the system.

ST. JOSEPH, MO.—It is proposed to issue $200,000 bonds this summer, to be used in extending the capacity of the city electric light plant.

PLATTSMOUTH, NEB.—The City Council has granted Chas. C. Parmele a franchise for an electric light, gas and heat plant.

JERSEY CITY, N. J.—The Century Light, Heat & Power Company has been incorporated here with a capital of $125,000.

TRENTON, N. J.—The Empire Light, Heat & Power Company has been incorporated with a capital of $125,000, by Ward W. Packard, George P. Fort and Thomas W. E. Middleton.

BROCKTON, N. Y.—The citizens have voted to construct an electric light plant, at a cost of about $10,000.

ROCHESTER, N. Y.—Bray & Albaugh, of Rochester, have secured the contract for building a storage dam across Oak Orchard Creek ravine for A. L. Levett, which is to develop 3,000 horse-power for electric transmission.

LIDGERWOOD, N. D.—Ralph Maxwell has petitioned for a franchise for an electric light plant.

COOPERSTOWN, N. D.—W. F. Ballard and Frank J. Becker are stated to have secured a franchise for an electric light plant.

ALBANY, N. Y.—The Corporate Electric Company has been incorporated here to manufacture electrictiy for light, heat and power purposes in Garden City, Long Island, and in the five boroughs of New York City. The capital is $300,000, and the directors are Harold S. Recknagel, Harold C. Vaughan and Walter L. Worrall, of New York City; C. C. Freeman and Henry C. Eldert, of Brooklyn. The People's Illuminating Company was also incorporated to supply electricity in Manhattan and Bronx Boroughs of New York City. The capital is $25,000, and the directors are C. C. Freeman and H. C. Eldert, Brooklyn; and W. L. Worrall, of New York City.

SHERODSVILLE, OHIO.—A franchise for an electric light plant has been granted to C. C. Bolen and A. H. Snively.

COLUMBUS, OHIO.—Bids will be received April 13 by John A. Connor, Clerk of the Board of Public Works, for erecting a municipal electric light plant.

MARIETTA, OHIO.—The council has placed contracts with the Ft. Wayne Electric Works and the Warren Electric Company for equipment for the new lighting plant. The city will erect electric arches on the main streets.

MARIETTA, OHIO.—A number of leading local merchants are forming a mutual company to erect a lighting plant to supply power and light to stockholders. It is probable the company will incorporate with $100,000 capital stock.

CINCINNATI, OHIO.—The directors of the Cincinnati Gas & Electric Company have decided to increase the capital of the company $1,000.000. The new stock will be sold by the company as the money is needed to pay for extensions and improvements.

NORTH YAMHILL, ORE.—F. L. Trullinger writes that bids will be received in June for an electric power plant, to cost about $15,000.

MIFFLINBURG, PA.—The Council is reported to have voted to construct a $10,000 electric light plant.

TUNKHANNOCK, PA.—The Tunkhannock Electric Light Company is stated to have purchased property on Tunkhannock Creek and the work of constructing a power plant will begin about July 1st.

NORTH EAST, PA.—The North East Electric Light & Power Company has been incorporated with a capital of $10,000. The incorporators are Henry Watts, of Buffalo, N. Y., and C. C. Hill, of North East.

ALTOONA, PA.—A new electric power plant installed at the Altoona machine shops of the Pennsylvania Railroad is now in operation. It includes three dynamos representing 1200 horse-power and furnishes light for the machine shops and railroad yard.

LANCASTER, PA.—The Edison Electric Illuminating Company has secured a contract for lighting the streets of this city with 300 arc lights at $93.50 per light. Last year the company charged $85 per light. There was no competition this year. The company claims that the increased cost is due to the high price of coal.

ROCK HILL, S. C.—The Rock Hill Light & Power Company has been permitted to increase its capital stock from $50,000 to $150,000. G. F. Reynolds is interested.

RAPID CITY, S. D.—Frank M. Lockhart and W. H. Chambers have secured a franchise for an electric light plant.

NORFOLK, VA.—The Economist Lighting Company has been granted a charter here. The capital is to be from $1,000,000 to $20,000,000. The officers are Samuel B. Lawrence, of New York, president; Alfred T. Davisson, of New York, vice-president; Henry C. Everdell, of New York, secretary, and John B. Summerfield, of New York, treasurer. These, with James W. Wilcox, of Norfolk, are the directors.

FOND DU LAC, WIS.—The Village Board of North Fond du Lac has decided to issue bonds for a municipal lighting plant.

STEVENS POINT, WIS.—It is reported that the Stevens Point Lighting Company will construct a water power plant. U. Mainland, of Oshkosh, is reported interested.

BURLINGTON, WIS.—The Burlington Electric Light & Power Company has been incorporated, with a capital of $50,000, by Leonard J. Smith and Clarence E. Partee.

MARINETTE, WIS.—The Isaac Stephenson Co., of Wells, Mich., is reported to have received plans from C. B. Pride, of Appleton, for a power plant to be built at Chandler Falls, on Escanaba River. The cost of the dam is estimated at $30,000, and of the complete electric plant and transmission line to Wells and Escanaba at $200,000.

WINNIPEG, MAN.—The City Engineer has been authorized to report on the approximate cost of machinery, etc., necessary to supply electricity for light and power by means of both steam and water power.

THE ELECTRIC RAILWAY.

LITTLE ROCK, ARK.—The Little Rock Railway & Electric Company has been incorporated as the successor of the Little Rock Traction & Electric Company, and the Little Rock Edison Electric Light & Power Company, both of which were recently purchased by Isidore Newman & Son, of New York and New Orleans. The corporators and directors of the new company are D. H. Cantrell, president; J. F. Loughborough, vice-president, and H. T. Bunn, secretary. The capital stock of the company is $2,250,000, divided into $750,000 preferred and $150,000 common stock.

BRIDGEPORT, CONN.—The Connecticut Railway & Lighting Company has awarded the H. Wales Lines Company, of Meriden, the contract for building an addition to the company's power house on Seaview Avenue. A new direct-connected unit is to be installed in the addition.

WILMINGTON, DEL.—The Morton Traction Company, of Wilmington, Del., capitalized at $100,000, has been incorporated by Elzy B. Van Atta, of New York City; Frank A. Field, Samuel S. Morton, of York, Pa.; David H. Lincoln, of Marion, Ohio.

WALLACE, IDAHO.—Plans are being discussed for the construction of an electric railway to connect Wardner, Wallace, Burke and Mullan. Elmer Hughes, of Missoula, is said to be interested.

ROCK FALLS, ILL.—The Dixon, Rock Falls & Southwestern Electric Railway Company has been incorporated, with a capital stock of $50,000. The incorporators and first board of directors are O. E. Maxson, A. S. Goodell, A. J. McNeill, R. L. Leitch and H. L. Sheldon, of Rock Falls, Ill.

PRINCETON, ILL.—The City Council has granted a franchise to the Illinois Valley Traction Company to operate its service in Princeton. It is expected a line now being built from Galesburg to Kewanee will be extended to Princeton, which, with one connecting link between Marseilles and Joliet, will make a continuous electric railway from Galesburg to Chicago, a distance of 160 miles.

INDIANAPOLIS, IND.—The incorporators of the Indianapolis, Green Castle & Western Traction Company have elected Frank M. Fauvre, president, and J. W. Chipman, secretary.

ANDERSON, IND.—The plans for the addition to the power house of the Union Traction Company at North Anderson are completed. Work on the building will soon be commenced.

INDIANAPOLIS, IND.—The Toledo & Chicago Interurban Railway Company has filed articles of incorporation with $500,000 capital stock. J. E. Rove, of Auburn, will furnish desired information.

LAGRANGE, IND.—The St. Joseph Valley Traction Company has filed articles of incorporation with a capital stock of $200,000. Directors: Rollin Ellison, M. V. Bilger, Jas. A. Roper, F. S. Fish, W. B. Pratt and others.

COLUMBUS, IND.—The Indiana Central Electric Railway Company has incorporated to build and operate a line from this city to West Baden and French Lick Springs. The initial capital stock is $20,000. Directors: John B. Burrell, John F. Stout, of Paoli; John Stratton, of Campbellsburg; H. C. Johnson and W. H. Shields, of Rockport.

INDIANAPOLIS, IND.—The Indiana Western Railway Company has incorporated with a capital stock of $1,000,000. The company proposes to build and operate street lines in, and connect the following cities with interurban lines: South Bend, New Carlisle, Laporte and Michigan City. The directors are D. D. Bates, H. F. Wurzer, John M. Brown, Eugene Miller and Wm. Stower, all of South Bend.

ANDERSON, IND.—The Union Traction Company, of Indiana, contemplates going into the electric lighting business, and will soon make an offer to various cities along its lines. The company is increasng its power house capacity here from 6,000 to 12,400 horse-power. Two-thirds of this will be required to operate its lines; the remainder will be sold. The company already has a number of sub-stations and will build more.

NEW ORLEANS, LA.—Northern capitalists are considering the question of building an electric railway in the Lake Pontchartrain District. J. F. O'Shaughnessy, of New York; S. H. Chisholm, of Cleveland; A. P. Bradstreet, of Waterbury, Conn., and U. Goodwin Reed, of Boston, are interested.

GRAND RAPIDS, MICH.—The Grand Rapids, Grand Haven & Muskegon Electric Railway will be extended to Highland Park.

DETROIT, MICH.—The Toledo & Monroe Railway has been sold to the Detroit, Monroe & Toledo Short Line Railway, a new corporation with a stock of $2,000,000. The road will be completed from Monroe to Detroit this spring. Present officers are Matthew Slush, president; C. A. Black, vice-president; Elisha Flinn, secretary; C. R. Hannan, treasurer.

WINONA, MINN.—The Winona Railway & Light Company contemplates spending about $100,000 in improvements. A steam turbine and a new condenser are to be installed in the power house, and new motors, new arc lights and other apparatus are to be purchased.

ST. LOUIS, MO.—The contract for the new power house to be built for the Terminal Railroad Association at 358-363 South Eighteenth Street, has been let to G. A. Fuller & Co. for $60,000.

KANSAS CITY, MO.—The Metropolitan Street Railway Company has taken out a permit for its new power house at Second and Grand Avenues. The building, exclusive of the excavation and equipment, will cost $300,000.

HAMSTEAD, N. H.—A charter for the Hamstead & Haverhill Street Railway has been granted by the Legislature. Among those interested are Isaac Randall, James W. Sanborn, Arthur M. Emerson, George R. Bennette, George Palmer, William A. Emerson, of Hamstead.

SYRACUSE, N. Y.—It is reported that the deal by which the Syracuse Rapid Transit Company absorbed the Syracuse, Lakeside & Baldwinsville Railway has been closed in New York and that $643,000 was paid for the road.

COLUMBUS, OHIO.—The leading lines of the Appleyard system are to be equipped with the block signal system of the United States Block Signal Company, of Boston.

UPPER SANDUSKY, OHIO.—Dr. J. D. Johnson and R. R. Dunham are promoting a railway system to radiate from Upper Sandusky and connecting Bucyrus, Marion, Corey, Tiffin and Sandusky.

MARIETTA, OHIO.—The Marietta, Woodsfield & Barnesville Electric Railway Company has been organized with R. Merydith, president; W. E. Daker, vice-president; T. M. Ripley, secretary; W. M. Hart, treasurer.

COLUMBUS, OHIO.—The Columbus, Bellefontaine & Northwestern Electric Railway Company has been incorporated, with $10,000 capital stock, by D. E. Sullivan, H. C. Grose, George Riddle, F. D. Sullivan and Charles F. Galloway.

CINCINNATI, OHIO.—The Cincinnati, Milford & Loveland Traction Company has closed a contract with the Falk Company, of Milwaukee, for the construction of 33½ miles of road from Cincinnati to Loveland. The power house will be erected at Milford.

MANSFIELD, OHIO.—The Citizen's Electric Railway, Light & Power Company which controls the local lighting plant and street railway system, as well as the Shelby-Mansfield line is to be succeeded by the Mansfield Railway, Light & Power Company. New capital has been interested in the company and the capital stock is increased to $1,000,000. Plans are being made to extend the interurban line.

MANSFIELD, OHIO.—The Capital City Traction Company has been incorporated, with $10,000 capital stock, under Ohio laws to build an electric railway system at Olympia, Washington. The officers are J. B. Weddell, Mansfield, president; J. B. Beckett, Cincinnati, vice-president; E. B. Connor, Coshocton, O., secretary, and A. S. Caton, Olympia, Wash., treasurer. The promoters are endeavoring to establish an Ohio colony near Olympia.

EL RENO, OKLA.—The City Council has granted S. F. Roberts and H. R. Canon, of El Reno, and John A. Bell and H. H. Carson, of Nashville, Tenn., a fifty-year franchise for the construction of an electric railway and electric light system here.

CONNELLSVILLE, PA.—The Mount Pleasant, Pleasant Unity & Baggagley Street Railway Company, has been chartered with a capital stock of $100,000. Construction work will be commenced shortly. W. C. Crow is president of the company.

PIERRE, S. D.—Articles of incorporation have been filed for the Black Hills & Spearfish Valley Electric Railway Company, at Spearfish, with a capital of $2,500,000. The directors are Hiram Dotson, Milton C. Conners, Frank Welch, Edward Granfield, Daniel J. Toomey, John D. Kingsley, John M. Caldwell, of Spearfish.

STAUNTON, VA.—The City Council has agreed to permit the City Street Car Company to operate its lines only five months during the year. The company stopped running cars eighteen months ago, contending that winter travel did not pay.

ST. MARYS, W. VA.—The Williamstown & Moundsville Railway Company has secured a 50-year franchise to build its line through the county. The company will also furnish light and power.

NEW INDUSTRIAL COMPANIES.

THE AUTOMOBILE COMPANY, of New Jersey, capital $100,000, has been incorporated by Harry H. Picking, Gardner W. Kimball and Charles A. Greene.

THE EQUITABLE X-RAY COMPANY, of Brooklyn, N. Y., has been incorporated with a capital of $2,000. Directors: E. E. Bennett, W. F. Bennett and W. D. Farrington, of Brooklyn.

THE MANVILLE COVERING COMPANY, with a capital of $150,000, has been incorporated by Harry Hill, Marmaduke Tilden, Jacob B. Merseles, Alexander Morrison, Jr., and Joseph V. Clark.

THE BALTIMORE ENGINEERING COMPANY, of New York, has been incorporated with a capital stock of $10,000. The incorporators are Louis S. Hubbard, G. E. Relyea and John A. Djerk.

THE GENERAL AUTOMOBILE AND MANUFACTURING COMPANY has been incorporated at Delaware, Ohio, with a capital stock of $125,000. Mr. M. L. Thompson, of Cleveland, is agent.

THE ELECTRIC CABLE JOINT AND APPLIANCE COMPANY, of New York City, has been incorporated, capital $100,000. Directors: W. M. Murphy, F. H. Wilmott and H. M. Randall, of New York City.

THE MOBILE RAPID TRANSIT COMPANY, of Irvington, N. Y., has been incorporated with a capital of $100,000. Directors: John Walker, Sr., John Brisben Walker and David S. Walker, Irvington.

THE FIELD CONDUIT CONTRACTING COMPANY, of New York, has been incorporated with a capital of $15,000. Directors: J. E. Clark, Jr., and G. B. Smith, New York; W. A. Cullen, Newark, N. J.

THE TELEPHINE COMPANY OF AMERICA has been incorporated at Washington, D. C., to manufacture, among other things, antiseptic attachments for telephone mouthpieces. The incorporators are O. H. Savage, J. T. Richards and E. L. Squire.

THE AMERICAN COMPOUND BEARING COMPANY has been incorporated in New Jersey to manufacture bearings for machinery. The capital stock is $125,000 and the incorporators are Osborne Congleton, Henry C. Wilson, Henry F. West, Kenneth K. McLaren and James C. Campbell.

THE FRONTIER ELECTRIC LIGHTING COMPANY, of Buffalo, has been formed by Buffalo Gas Company interests with a capital stock of $800,000. The directors are Alexander C. Humphries, Frederick Strauss and Stephen Peabody, New York; Howard L. Clark, Providence, R. I., Franklin D. Locke, Buffalo.

PERSONAL.

PROF. A. J. WOOD.

PROF. A. J. WOOD.—The trustees of Delaware College, Newark, Del., have just awarded Prof. Wood several thousand dollars to enable him to give the electrical and mechanical departments an equipment that will be up to date and enable the studies to be conducted with greater efficiency. Prof. Wood is a son of the late Prof. De Volsom Wood, so well known for his work at the Stevens Institute of Technology. He was born at Roseville, N. J., in 1874, graduated from the Boonton High School, and from Stevens in 1896 with the degree of mechanical engineer. In 1897 he attended lectures on advanced mechanics at Columbia University, and until 1900 was on the editorial staff of the "Railroad Gazette." During this period he gave special attention to matters connected with electric traction; as well as acceleration of trains and gas engine design. His investigations on hydraulic rams, printed in the "Stevens Institute Indicator," also embodied a large amount of original work. Before going to Newark, Del., Prof. Wood was an instructor in mechanical engineering at the Worcester Polytechnic Institute for about one and one-half years, and he has also acted as consulting engineer in regard to a number of enterprises. Since 1899, Prof. Wood has been a member of the council of the Society for the Promotion of Engineering Education. In 1898 he was elected to the American Society of Mechanical Engineers, and in 1899 he joined the American Institute of Electrical Engineers. Prof. Wood has done a variety of original work on electrical apparatus, and is now laying out broad plans for the useful development of the department under his care, so that his students may not only be well grounded, but undertake the foremost branches of electrical engineering. In connection with such work, the students have recently formed an engineering society, and Prof. Wood has already been able to attract to Newark for its benefit a number of well-known popular lecturers in the engineering field; giving the society considerable prestige and stimulus.

MR. T. A. EDISON has returned to his home in Orange, N. J., from his plantation in Florida, where he always spends a part of the winter.

MR. W. D. SARGENT, vice-president and general manager of the New York & New Jersey Telephone Company, has returned home to Brooklyn, N. Y., from his wedding trip in the far South.

MR. ARCHIE KELLY, A. M. I. E. E., a member of the consulting electrical engineering firm of Lester Taylor, Kelly & Hide, of Liverpool, is now visiting the United States and making a tour of inspection as far west as Chicago.

MR. JOHN R. GEARY, of the General Electric Company, has gone to Japan with a view to representing permanently the interests of that company in the Mikado's Empire. Mr. Geary will make his headquarters at Yokohama.

MR. I. STERNFELD, of G. & O. Braniff, Mexico City, representing the Westinghouse electrical interests in the Southern Republic is now in New York. He is making his headquarters at the offices of the Westinghouse Company.

MR. HUGH L. COOPER, an engineer, of Montreal, has gone to Mexico where he will take up his work as resident engineer of the Mexican Light & Power Company. Mr. F. S. Pearson, vice-president of the company accompanied him.

MR. E. R. KNOWLES, C. E., is consulting electrical engineer for the new plant which the American Type Founders Company is putting up at Communipaw, N. J., and which will include a great many machines run by separate motors.

MR. J. SHAW, of the power and mining department of the British Thomson-Houston Co., Ltd., at Rugby, England, arrived here by the *Umbria* last week, and will spend some weeks in looking up General Electric methods and installations.

MR. RALPH D. MERSHON, the consulting electrical engineer, who has lately been closely engaged on power plant and transmission work at Montreal, Can., expects to sail from New York to England on April 10, to be gone until the middle of May.

MR. H. J. DOUDS, who up to the beginning of the year was manager of the supply department of the General Electric Company at Cincinnati, Ohio, has since that time been connected with the engineering firm of J. G. White & Co., in New York City.

MR. E. S. MACKIN, of the American contracting firm of Mackin and Dillon, is now in New York, regarding the Monterey electric traction project, in the realization of which there is expected to be some delay. Mr. Mackin is a guest at the Van Rensselaer Hotel.

MR. H. C. PATTERSON has opened an office at 17 State Street, New York, as an electrical, mechanical and hydraulic engineer. Mr. Patterson's experience dates back to 1881 with the old T-H Edison companies and latterly he was with the General Electric Company.

MR. ERNEST F. SMITH, assistant to the chief operating engineer of the Chicago Edison and the Commonwealth Electric Companies, has been elected vice-president and general manager of the St. Joseph Boat Manufacturing Company, St. Joseph, Mich. Mr. Smith will retain his present position with the Edison and Commonwealth companies.

MR. A. W. McLIMONT, some time president of the Federal Electric Company, 141 Broadway, New York, and who more recently acted as chief engineer in connection with the Monterey, Mexico, electric traction project, sailed this week for Peru for the purpose of superintending the construction of the proposed Lima-Chorillos electric road.

MR. J. B. D'HOMERGUE, manager of the "Keystone Hair Insulator" department, of the H. W. Johns-Manville Co., sailed on March 30 for England, where he will make an exhaustive and comprehensive investigation of the trade for asbestos and sound-deadening materials in that country. Upon his return, about May, he will be permanently located in New York.

MR. A. K. T. BULKLEY, of Bulkley & Bowden, Johannesburg and Durban, South Africa, is now in the United States for the purpose of placing some substantial orders for electrical equipment, machine tools, etc. He is in the West, but will return next week. While in New York he will make his headquarters at the offices at 116 Broad Street, of the export firm of Cadenas & Co.

MR. B. A. BEHREND, Chief Engineer of the Bullock Electric & Mfg. Company, on his recent visit to California, delivered two lectures to the electrical students of Stanford University on "Design of Alternating Current Machines." Mr. Baum, of the Electrical Department is arranging for a series of lectures to be given by practical men of recognized standing in the profession.

MR. J. K. ROBINSON, Iquique, Chili, who represents the Westinghouse interests on the west coast of South America, is due to arrive in New York April 21, en route for London, where he will go regarding some important contracts pending for electrical equipment, etc., in Chili and Peru. On his return from the other side, he is expected to place some heavy orders before sailing for South America.

MR. CHARLES J. GLIDDEN, the well-known telephone manager, who has of late been making some remarkably long automobile tours in this country and Europe, is to spend this summer in Scandinavia, and proposes to push his auto to within 2½ degrees of the Arctic circle, in Norway, and starting from England. The total distance, including local steam travel, will be 4,406 miles, and the time scheduled 45 days.

MR. F. P. FISH.—President Fish of the American Telegraph & Telephone Company has returned to Boston from an inspection of some of the important exchanges of the local telephone companies. During the past six months he has visited some of the larger exchanges east of the Mississippi River with a view of forming an opinion on the extensive construction required in the territory of the sub-companies during the coming summer.

MR. F. G. BAUM, of the Electrical Department of Stanford University has accepted the position of assistant electrical engineer to the chief engineer, Mr. L. M. Hancock, of the California Gas & Electric Corporation. Under Mr. Hancock, Mr. Baum will have general charge of the electrical engineering and operation of the system. For the present Mr. Baum is continuing his classes at the University, giving his spare time to the work of the corporation.

MR. FERDINAND W. PECK, who was commissioner general of the display made by the United States at the Paris Exposition of 1900, and Dr. Lee De Forest, the scientific director of the De Forest Wireless Telegraph Company, visited the administration Building at the St. Louis Exposition on April 3. The De Forest Company will make an exhibit in the Electricity Department and may give demonstrations of the practical use of wireless telegraphy on the grounds during the Exposition.

MR. V. C. GILPIN, who was formerly New York agent for the Cutter Electric Mfg. Company and two years with the Supply Dealers' Association as supervisor, joined the forces of the De Veau Telephone Mfg. Company a few months ago. He has just returned to New York after a long and successful trip in behalf of the De Veau specialties, and has very interesting stories to tell as to telephonic development in the Middle and Western States. He considers the telephone industry one of the most progressive in the electrical field at the present time.

MR. ANDREW CARNEGIE has begged to be allowed to pay all bills incurred by students of Cornell University on account of sickness during the recent typhoid epidemic at Ithaca in all cases where the students or their parents will permit it. It is Mr. Carnegie's desire to place each student who has been ill in precisely the same pecuniary condition as that which he occupied at the outbreak of the epidemic. The gift is applicable to all sick students, those who withdrew from the university as well as those who remained at Ithaca. Mr. Carnegie has also offered to aid in ensuring a pure water supply hereafter.

MR. J. B. ORR, one of the resident partners at Rio Janeiro of the electrical engineering and contracting firm of James Mitchell & Company, of Rio Janeiro, Brazil, which concern represents the interests of the General Electric Company, the Pelton Water Wheel Company, Babcock & Wilcox Company and other prominent American concerns, is now visiting the United States. At time of writing he was in the West, but he is expected to be in New York early next week. It is anticipated that he will place some substantial contracts for various electrical equipments, etc., before he returns to Brazil next month. While in New York he may be found in the Brazilian department of the American Trading Company, Broad Exchange Building.

PROF. A. A. ATKINSON.—In a recent personal note, D. Van Nostrand Company in their monthly bulletin say: Prof. A. A. Atkinson, of the "Ohio University," should not be confounded with the late Mr. Philip Atkinson, of Chicago. The latter was the author of three works of merit in "Electrical Science," namely: "Elements of Electric Lighting," "Elements of Dynamic Electricity and Magnetism," "Power Transmitted by Electricity and Its Application by the Electric Motor, including Electric Railway Construction," and "Elements of Static Electricity," all of which are standard works and have had a large sale. The former is the author of a more recent work, entitled, "Electrical and Magnetic Calculations for the Use of Electrical Engineers and Artisans, Teachers, Students and all Others Interested in the Theory and Application."

MR. F. A. LA ROCHE.—Considerable interest and curiosity was aroused in electrical circles this week by the action of Mr. F. A. La Roche, the well-known electrical manufacturer and automobilist, in appearing in the Jefferson Market police court, of New York City, as complainant against John St. Clair, a private detective, who he said had been shadowing him. Mr. La Roche is a witness for the defense in the patent suit case of the Weston Electric Instrument Company against the Empire Electrical Instrument Company, which

is pending in the United States Circuit Court. Mr. La Roche said that he has been constantly shadowed for two months. St. Clair, he said, followed him on a bicycle when he went out in his automobile and he or some other sleuth was always on guard before his factory or at his home, 140 West Fifteenth Street. Magistrate Barlow held St. Clair in $300 bonds for examination.

MR. WILLIAM C. ANDREWS, for the past two years associate editor of the *Street Railway Journal*, has accepted the position of Eastern representative of E. P. Roberts & Co., consulting engineers, Cleveland. The increasing Eastern business of this company has made it advisable to open a New York office, of which he will have charge. Mr. Andrews is a graduate of Columbia University, School of Mines, receiving the degree of electrical engineer in 1895. After a year in Europe, he spent another year with the Royal Electric Company, of Montreal, in the lighting and manufacturing departments. In 1897 he entered the post-graduate course at Cornell University, but left in the early spring of 1898 to become assistant in physics at Columbia University where he remained until 1900. He then became connected with the McGraw Publishing Company in the editorial department of ELECTRICAL WORLD AND ENGINEER, and was later associate editor of the *Street Railway Journal*, which position he held until recently.

MR. S. T. DODD.—In the S. K. C. club rooms at Pittsfield, Mass., Mr. S. T. Dodd, engineer of the street railway department of the Stanley Electric Mfg. Co., gave, last week, an exceedingly interesting lecture on the development of street railway apparatus. This was particularly interesting to Berkshire shire people on account of one of the first railway motors having been invented and made by Mr. Stephen D. Field, of Stockbridge. It was named "The Judge," in honor of the uncle of the inventor, Chief Justice Field, and was operated in Chicago in 1883. Mr. Dodd illustrated his lecture with lantern slides, together with anecdotes and personal reminiscences of men and events in connection with the development of street railway apparatus, and pointed out the improvements made from time to time on this apparatus. The S. K. C. club has arranged for lectures covering the next two or three months, and as the subjects are of interest to employees, they are having quite a large attendance. The evening's entertainment was considerably enhanced by the S. K. C. orchestra of 33 pieces. This orchestra is one of the leading features of the entertainments which the club has organized.

OBITUARY.

MR. L. T. LAWTON.—We regret to note that Lyman T. Lawton, widely known as an electrical inventor, died at Meriden, Conn., on April 3, aged fifty-five years. He was formerly President of the Automatic Lighting Company and the Connecticut Telephone and Electric Company.

LEGAL.

SUIT TO RECOVER A NICKEL.—Dr. Elmer Prescott, in his suit against the Chicago Telephone Company to recover a nickel which he alleged he had dropped into a telephone, and for which he received no service, was awarded judgment for five cents by Justice Blume on March 30. The company appealed the case to a higher court.

CHICAGO TELEPHONE RATE CASES.—Hundreds of lawsuits are to be brought at once against the Chicago Telephone Company to recover money claimed to have been collected by the company in excess of the rate authorized by city ordinance. The complainants have organized the Chicago Telephone Adjustment Company, which will attend to the litigation for its members. William B. Judd is president of the company. Eighteen suits have already been started. These actions are the consequence of the proceedings brought by the Illinois Manufacturers' Association to compel the telephone company to reduce its annual charge to the $125 specified by ordinance. Judge Tuley found that the company had no right to charge the tolls in force, which ran up to $175 and more in many cases.

Trade Notes.

BUFFALO FORGE COMPANY, of Buffalo, N. Y., has removed its Pittsburgh office to 607 House Building, corner Smithfield and Water Streets, where it will be continued in charge of Mr. H. D. Wilson, M. E.

THE UNITED ELECTRIC HEATING COMPANY, which has been carrying on business at 260 Randolph Street, Detroit, Mich., as manufacturer of electric heating devices, has incorporated under the old name.

ARMOUR & COMPANY are making tests at the Union Stock Yards, Chicago, of the Nernst lamp, manufactured by the Nernst Lamp Company, of Pittsburg, preparatory, it is understood, to an extensive installation of this lamp in their offices and works.

C. F. SPLITDORF, 17 Vandewater St., New York, has recently been compelled to increase his factory by taking an extra floor. This has been made necessary by the constantly increasing demand for his well-known spark coils for X-ray, wireless telegraphy and gas engine ignition. This business was established in 1858.

LOWE & LEVERIDGE, general electrical supplies, New York City, have taken a lease of the entire building at 183 Greenwich Street, from May 1. This will give them a great deal more space for all departments of their business, and they are ready to take on one or two more suitable agencies for outside electrical manufacturers.

PLATINUM.—The well-known firm of J. Bishop & Co., refiners and dealers in platinum and manufacturers of platinum wire, have recently removed from Sugartown to Malvern, Pa., where they are permanently located, and are in possession of increased facilities. This firm was established in 1842, and is said to be the oldest of its kind in this country.

THE ELECTRIC CONTRACT COMPANY has removed from 53 Maiden Lane, New York, to 202 and 204 Centre Street, where it has a thoroughly equipped new factory. This move was made necessary by the steady increase of its business in the various lines of electric novelties, flashlights and other specialties. Mr. Charles P. Skinner, vice-president, says it will now be able to fill all orders promptly and in any quantity.

CLEATS.—James S. Barron & Co., 200 West Broadway, New York, are making a specialty of porcelain and wood office cleats for the use of telephone companies. Some of these cleats are illustrated in a sheet just issued by the firm. Among those illustrated are small double grooved cleats, porcelain single grooved cleats and backing, fancy and plain single grooved cleats, Circular Loom cleats and cross-arm connecting cleats. The dimensions and prices of these cleats are given.

CRANDALL PACKING.—On account of its constantly increasing business, the Crandall Packing Co. has found it necessary to have larger quarters in which to conduct the volume of trade emanating from its New York office. It has leased commodious offices at No. 123 Liberty St., where its salesroom will be located. Mr. S. M. Hildreth, local manager, will be very glad to welcome its numerous customers at the new location and explain the various packings, which should be interesting to all users of steam goods.

THE ENGINEERING AGENCY, Monadnock Block, Chicago, received applications in one day last week for 67 high-grade technical men; one company asking for 25 blast furnace draftsmen at $125 to $150 a month and another company for 30 structural draftsmen at $125 a month. The Agency has vacancies on its books for over 200 competent men, including instructors in shop work for technical colleges, teacher for manual training school, assistant editor for technical journal, chemists, engineers of all kinds, shop superintendents, draftsmen, etc.

THE NERNST LAMP COMPANY, of Pittsburg, Pa., opened an office in the National Life Building, Chicago, on April 1st. The large number of alternating-current circuits and plants in the Chicago district have helped to increase the demand for Nernst lamps beyond the point where a local office can be dispensed with. A stock sufficiently large to supply the trade and consumers promptly will be carried. The rapidly increasing popularity of this lamp promises to be an important factor in the illuminating field, as is evidenced by the number of large contracts recently placed for its installation in important buildings and manufacturing plants.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MARCH 31, 1903.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

723,804. STORAGE BATTERY; J. M. Allen, St. Louis, Mo. App. filed July 21, 1902. The electrodes are in the form of rectangular boxes which are designed to prevent buckling.

723,817. ELECTRIC CURRENT CONTROLLER; L. Bradley, Milwaukee, Wis. App. filed Nov. 11, 1901. The invention consists of means for gradually applying pressure to a stack of resistance disks.

723,836. INDUCTION APPARATUS; P. F. Cowing, New York, N. Y. App. filed Oct. 24, 1902. The primary of an induction coil and one-half of the core are mounted on the under side of a table or board, while the secondary winding and other half of the core, together with a lamp and fixture in circuit with the secondary, is adapted to be placed against the top—or front of the table or board. By altering the angular position of the two coils with respect to each other, the induced current to the lamp is controlled.

723,840. CONTROLLING SWITCH SYSTEM; A. L. De Leeuw, Hamilton, Ohio. App. filed Oct. 13, 1902. To cause electro-magnetic clutches to release promptly, a reversed polarity is sent through the coil an instant before the release is desired.

723,845. ALARM AND ANNUNCIATOR; R. J. Dodd, Cottage Place, Va. App. filed April 16, 1902. The inside of an electric bell-gong is provided with a reflecting surface and a lamp which is lighted when the gong rings.

723,866. ELECTRIC SWITCH; G. W. Hart, West Hartford, Conn. App. filed July 19, 1902. The front plate of a plug socket is provided with a shutter which is automatically opened to admit the plug and closed when the plug is removed.

723,928. ELECTRO ENDOSMOTIC PROCESS OF EXTRACTING SUGAR; B. Schwerin, Berlin, Germany. App. filed Nov. 15, 1901. Consists in causing the albuminous matter to separate out at the negative electrode and in converting the acid accumulating in the beginning of the process in the water at the positive electrode into indissoluble and innocuous compounds. (See page 618.)

723,982. TILE OR CONDUIT FOR ELECTRIC CONDUCTORS; R. W. Lyle, Perth Amboy, N. J. App. filed July 1, 1902. Details of a key for connecting the sections of the tile together.

723,989. POLE SHOE FOR DYNAMO ELECTRIC MACHINES; A. Churchward, Chicago, Ill. App. filed Aug. 23, 1901. The shoe which is applied to cores having interrupted pole faces, is also discontinuous or interrupted.

724,012. PROCESS OF MAKING ELECTRIC ACCUMULATOR PLATES; J. J. H. Hunte, Charlton, Eng. App. filed April 15, 1902. In order to shorten the process of forming the plates, they are subjected to the action of chlorine and oxygen in a specific way.

724,021. AUTOMOBILE VEHICLE; H. Lemp, Lynn, Mass. App. filed April 25, 1900. Separate motors are applied to independent drive wheels, each motor having a series field winding which is connected to the other through a bridging connection; a series multiple controller is used.

724,060. TRANSFORMING SYSTEM; N. Thomas, Jr., London, Ohio. App. filed Nov. 25, 1901. A transforming system comprising two oppositely disposed induction coils, a source of electricity to which the primaries of the coils are connected mutually in multiple and individually in series, the secondaries being connected through independent transmitting circuits to a common working circuit, and a vibrator connected in the primary circuit and adapted to alternately make and break the circuits through the primaries of the coils.

724,069. ELECTRIC FURNACE; R. Winter, Berlin, Germany. App. filed Aug. 7, 1901. Tubes of refractory material containing the heating resistance are arranged as a lining on the inner walls of the furnace.

724,071. ELECTRIC ARC LAMP; T. E. Adams, Cleveland, Ohio. App. filed Jan. 18, 1902. A horizontally pivoted frame carries a coarse wire coil at one end and a fine wire coil at the other, stationary armatures co-operate with these coils and clutch operating devices are connected with the frame.

724,072. ALTERNATING CURRENT ARC LAMP; T. E. Adams, Cleveland, Ohio. App. filed March 12, 1902. A modification of the preceding patent.

724,073. ALTERNATING CURRENT REGULATOR; T. E. Adams, Cleveland, Ohio. App. filed March 26, 1902. The current is regulated by the counter-electromotive force of self-induction caused by the automatic lifting of a coil to more or less cover an iron core.

724,089. MEANS FOR OPERATING MOTORS IN DUST-LADEN ATMOSPHERES; T. A. Edison, Llewellyn Park, N. J. App. filed January 9, 1903. (See Current News and Notes.)

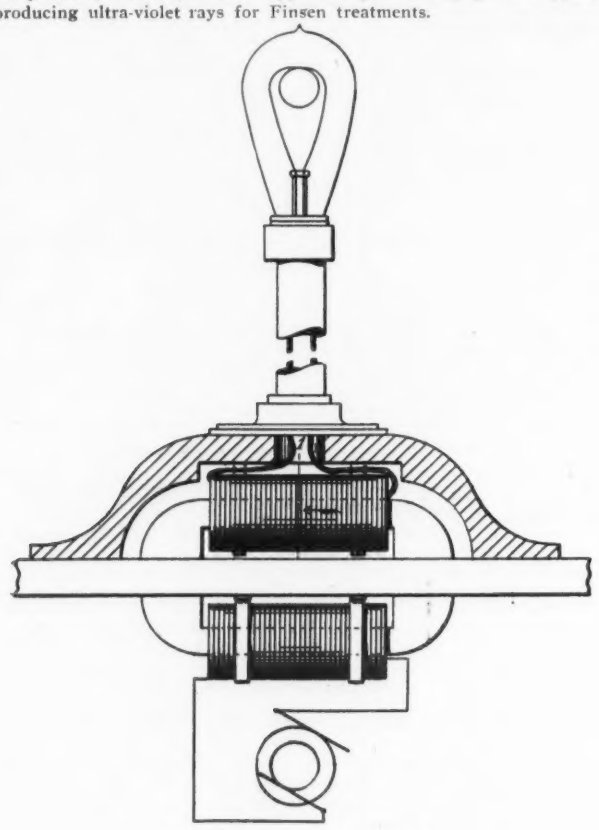
724,099. TROLLEY WHEEL; J. Henger, North Amherst, Ohio. App. filed June 30, 1902. Details.

724,102. ELECTRIC FLASHER AND CIRCUIT THEREFOR; H. C. Horstmann, Chicago, Ill. App. filed March 28, 1902. The object is to provide a simple mechanism to operate and control a number of circuits through which the current is flashed at intervals, in a manner to avoid sparking.

724,107. COMPOSITION OF MATTER FOR ELECTROLYTIC DEPOSITION; E. D. Kendall, New York, N. Y. filed Sept. 17, 1902. A solid compound consisting of a suitable aurate and a suitable ferrocyanide which by mere solution in water furnishes an electrolyte available for the deposition of gold.

724,144. ATTACHMENT FOR ELECTRIC GENERATORS; E. A. Terpening, Geneseo, Ill. App. filed Jan. 10, 1903. A commutator attachment capable of a wide range of adjustment to enable it to be used with generators of various dimensions.

724,186. ELECTRICAL APPARATUS FOR THERAPEUTICAL WORK; H. Jackson, Newton, Mass. App. filed Jan. 22, 1903. An apparatus for producing ultra-violet rays for Finsen treatments.



723,836.—Induction Apparatus.

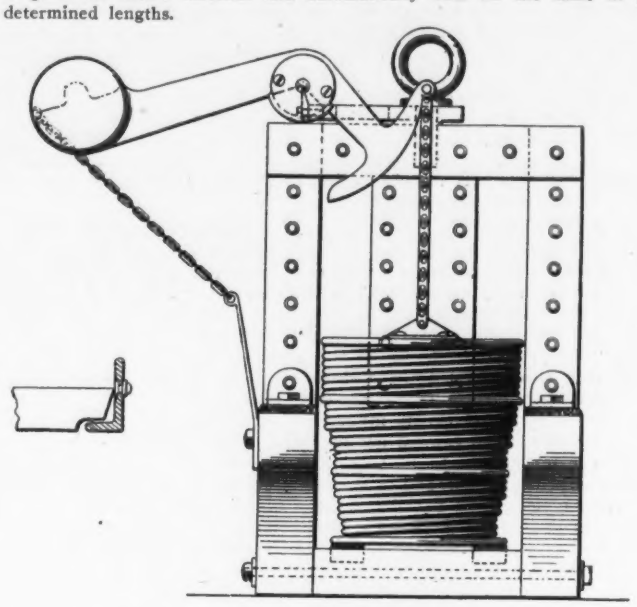
724,191. CELL FOR ELECTROLYTIC BLEACHING PLANT; L. E. Lander, Warren, N. H. App. filed Sept. 22, 1902. The cell is of iron and protected from attack by the chlorine gas by a covering of asbestos.

724,228. ELECTRIC CIRCUIT BREAKER; J. J. Wood, Fort Wayne, Ind. App. filed May 8, 1901. The arc is blown out by the gases which it generates.

724,229. ELECTRIC ARC LAMP; J. J. Wood, Fort Wayne, Ind. App. filed April 23, 1902. An arc lamp having its feed controlling magnetic element proportioned to render the lamp self-compensating for temperature changes.

724,274. SIGNALING APPARATUS; H. A. Fessenden, Detroit, Mich. App. filed Nov. 19, 1900. A signal constructed to operate progressively and of necessity requiring to be reset to its initial position after each operation; it is useful especially on ships.

724,287. MANUFACTURE OF ELECTRODES; Jean Jacques Heilmann, of Paris, France. App. filed September 6, 1900. A mechanism for manufacturing storage battery plates of the class comprising a central core and a coating of active material. The machine automatically coats the core for the proper length with active material and automatically cuts off the same in predetermined lengths.



724,073.—Alternating Current Regulator.

724,329. INSULATOR; R. H. Polk, Birmingham, Ala. App. filed June 17, 1902. An insulator having specially formed notches by which the wire can approach it at any angle and still be securely held.

724,339. LIGHTNING ARRESTER; H. M. Shaw, Newark, N. J. App. filed Sept. 20, 1901. Alternate plates of carbon and mica are inserted between the serrated terminals.

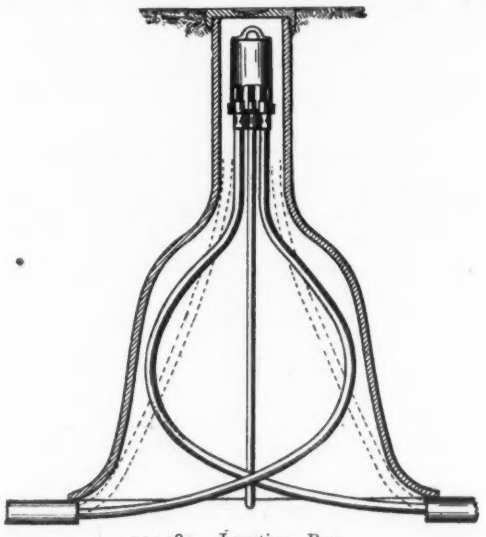
724,351. INSULATED STRAIN; L. Steinberger, Brooklyn, N. Y. App. filed Aug. 25, 1902. Details.

724,361. CUT OUT; O. B. Williams, Whitewater, Wis. App. filed Oct. 22, 1902. Details.

724,366. ELECTRIC ARC LAMP; J. J. Wood, Fort Wayne, Ind. App. filed March 19, 1902. Improvements in the various features of the lamp.

724,367. ELECTRICAL TRACTION TOWAGE; S. W. Wood, New York, N. Y. App. filed June 25, 1902. Three rails placed one above the other along the canal bank are traversed by motor driven carriages.

724,368. ELECTRICAL TOWAGE ON CANALS; S. W. Wood, New York, N. Y. App. filed June 25, 1902. A modification of the preceding system in which the middle rail carries the current, while the upper and lower rails are the return conductors for two lines of carriages.



724,383.—Junction Box.

724,383. JUNCTION BOX; R. S. Donaldson, Cleveland, Ohio. App. filed June 4, 1900. The box is for underground heavy cables and has an enlargement at its base permitting the cable to make a gentle sweep in entering the box.

724,387. METHOD OF PRODUCING STORAGE BATTERY PLATES; W. Gardiner, Chicago, Ill. App. filed Dec. 13, 1900. A process of oxidizing lead plates consisting in passing a current from the plates through an electrolyte containing three acids, one of which is a good solvent of lead, another a poor solvent of lead, and the third an organic acid.